

Daniel Johnson Jr. (Bar No. 57409)
Mario Moore (Bar No. 231644)
Robert G. Litts (Bar No. 205984)
DAN JOHNSON LAW GROUP, LLP
1350 Old Bayshore Highway, Suite 520
Burlingame, CA 94010
Telephone: (415) 604-4500
dan@danjohnsonlawgroup.com
mario@danjohnsonlawgroup.com
robert@danjohnsonlawgroup.com

Lyle B. Vander Schaaf (DC Bar No. 422380)
Fei Hu (DC Bar No. 1016150)
BRINKS GILSON & LIONE
1775 Pennsylvania Ave, NW, Suite 900
Washington, DC 20006
Telephone: (202) 296-8700
lvanderschaaf@brinksgilson.com
fhu@brinksgilson.com
Appearance *pro hac vice*

Harold V. Johnson (IL Bar No. 6188149)
BRINKS GILSON & LIONE
455 N. Cityfront Plaza Drive, Suite 3600
Chicago, IL 60611
Telephone: (312) 321-4200
hjohnson@brinksgilson.com
Appearance *pro hac vice*

Attorneys for Defendant
Fujian Jinhua Integrated Circuit Co., Ltd.

**IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF CALIFORNIA**

MICRON TECHNOLOGY, INC.,

Plaintiff,

v.

UNITED MICROELECTRONICS
CORPORATION, FUJIAN JINHUA
INTEGRATED CIRCUIT CO., LTD.,
and DOES 1-10,

Defendants.

Case No. 3:17-CV-6932-MMC

**DECLARATION OF MARIO MOORE
IN SUPPORT OF DEFENDANT FUJIAN
JINHUA INTEGRATED CIRCUIT CO.,
LTD.'S OPPOSITION TO PLAINTIFF
MICRON TECHNOLOGY, INC.'S
MOTION TO LIFT STAY**

Date: January 8, 2021
Time: 9:00 a.m.
Judge: Hon. Maxine M.
Chesney
Courtroom: 7, 19th Floor

1 I, Mario Moore, hereby declare as follows:

2 1. I am an attorney licensed to practice law in the State of California, and I am admitted to
3 practice before this Court. I am a partner at Dan Johnson Law Group, LLP, and I am one of the
4 attorneys representing Fujian Jinhua Integrated Circuit Co., Ltd. (“Jinhua”) in the above-captioned
5 matter. I submit this declaration in support of Jinhua’s Opposition to Plaintiff Micron Technology,
6 Inc.’s Motion to Lift Stay. I make this declaration on personal knowledge, and if called as a
7 witness, I could and would competently testify with respect to the matters stated herein.

8 2. Attached hereto as Exhibit **A** is a true and correct copy of Micron’s notice of document
9 subpoena to Applied Materials, Inc., dated June 4, 2019.

10 3. Attached hereto as Exhibit **B** is a true and correct copy of Kahn, “U.S. Semiconductor
11 Exports to China: Current Policies and Trends,” dated October 2020.

12 4. Attached hereto as Exhibit **C** is a true and correct copy of “Taiwan’s UMC freezes ties
13 with Chinese firm in response to US sanctions,” *Taiwan News*, dated November 1, 2018.

14 5. Attached hereto as Exhibit **D** is a true and correct copy of “Micron bets on Xi'an plant for
15 accolades,” *China Daily*, dated April 16, 2020.

16 6. Attached hereto as Exhibit **E** is a true and correct copy of “Micron says emerging Chinese
17 rivals pose no threat -- for now,” *Nikkei Asia*, dated October 7, 2020.

18 7. Attached hereto as Exhibit **F** is a true and correct copy of “Experience is more important
19 than money: Micron does not believe in the imminent success of Chinese memory manufacturers
20 and is not afraid of competition with them,” *Tech News for You Daily*, retrieved December 17,
21 2020.

22 8. Attached hereto as Exhibit **G** is a true and correct copy of a Semicon Taiwan presentation
23 “Memory Technology and Overall Trends in the Semiconductor Industry.”

24 9. Attached hereto as Exhibit **H** is a true and correct copy of “DRAM, NAND and Emerging
25 Memory Technology Trends and Developments in 2019,” *Semiconductor Digest*, dated September
26 13, 2019.

27 10. Attached hereto as Exhibit **I** is a true and correct copy of Micron’s notice of document
28 subpoena to KLA-Tencor Corporation, dated June 4, 2019.

1 I declare under penalty of perjury under the laws of the United States of America that the
2 foregoing is true and correct to the best of my knowledge and belief.

3
4 Executed this 18th day of December 2020, in Irvine, California.

5
6 DAN JOHNSON LAW GROUP, LLP

7
8 /s/ Mario Moore
9 Mario Moore (Bar No. 231644)

Exhibit A

Randall E. Kay (State Bar No. 149369)
rekay@jonesday.com
Douglas L. Clark (State Bar No. 279408)
dlclark@jonesday.com
JONES DAY
4655 Executive Drive, Suite 1500
San Diego, CA 92121.3134
Telephone: +1.858.314.1200
Facsimile: +1.844.345.3178

Patrick T. Michael (State Bar No. 169745)
pmichael@jonesday.com
Marcus S. Quintanilla (State Bar No. 205994)
mquintanilla@jonesday.com
JONES DAY
555 California Street, Suite 2600
San Francisco, CA 94104.1501
Telephone: +1.415.626.3939
Facsimile: +1.415.875.5700
Attorneys for Plaintiff
MICRON TECHNOLOGY, INC.

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA

MICRON TECHNOLOGY, INC.,

Plaintiff,

v.

UNITED MICROELECTRONICS
CORPORATION, FUJIAN JINHUA
INTEGRATED CIRCUIT CO., LTD., and
DOES 1-10,

Defendants.

Case No. 3:17-CV-06932-MMC

**NOTICE OF SUBPOENA TO
PRODUCE DOCUMENTS**

TO ALL PARTIES AND THEIR ATTORNEYS OF RECORD:

PLEASE TAKE NOTICE that pursuant to Fed. R. Civ. P. 45, Plaintiff Micron Technology, Inc. ("Micron") will serve upon the following entity on June 4, 2019, or as soon as possible thereafter, the attached subpoena to produce documents:

Applied Materials, Inc.

c/o Corporation Service Company

Which Will Do Business in California as CSC - Lawyers Incorporating Service

2710 Gateway Oaks Dr., Ste 150N

Sacramento, CA 95833

Dated: June 4, 2019

JONES DAY

By: s/ Douglas L. Clark
Douglas L. Clark

Attorneys for Plaintiff
MICRON TECHNOLOGY, INC.

I, Douglas L. Clark, declare:

I am a citizen of the United States and employed in San Diego County, California. I am over the age of eighteen years and not a party to the within-entitled action. My business address is 4655 Executive Dr., Suite 1500, San Diego, CA 92121. On June 4, 2019, I served a copy of the foregoing document(s):

• **NOTICE OF SUBPOENA TO PRODUCE DOCUMENTS TO APPLIED MATERIALS, INC.**



by transmitting *via e-mail or electronic transmission* the document(s) listed above to the person(s) at the e-mail address(es) set forth below.

***Attorneys for Defendants United
Microelectronics Corporation and Fujian
Jinhua Integrated Circuit Co., Ltd.***

Daniel Johnson, Jr., Esq.
Sean P. DeBruine, Esq.
Mario Moore, Esq.
Robert G. Litts, Esq.
DAN JOHNSON LAW GROUP, LLP
400 Oyster Point Boulevard, Suite 321
South San Francisco, CA 94080
Telephone No.: (415) 604-4500
Email: dan@danjohnsonlawgroup.com
sean@danjohnsonlawgroup.com
mario@danjohnsonlawgroup.com
robert@danjohnsonlawgroup.com

***Pro Hac Vice Attorney for Defendant
Fujian Jinhua Integrated Circuit Co., Ltd.***

Lyle B. Vander Schaaf, Esq.
Evi Thomae Christou, Esq.
Fei Hu, Esq.
Judy Kelly He, Esq.
Harold V. Johnson, Esq.
BRINKS GILSON & LIONE
1775 Pennsylvania Ave. NW, Ste. 900
Washington, DC 200006
Telephone: (202) 296-6941
Email: lvanderschaaf@brinksgilson.com
echristou@brinksgilson.com
fhu@brinksgilson.com
jhe@brinksgilson.com
hjohnson@brinksgilson.com

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on June 4, 2019, at San Diego, California.

s/ Douglas L. Clark
Douglas L. Clark

NAI-1507696020v1

AO 88B (Rev 02/14) Subpoena to Produce Documents, Information, or Objects or to Permit Inspection of Premises in a Civil Action

UNITED STATES DISTRICT COURT

for the

Northern District of California

MICRON TECHNOLOGY, INC.

Plaintiff

v.

UNITED MICROELECTRONICS CORPORATION,
ET AL.*Defendant*

Civil Action No. 3:17-CV-06932-MMC

SUBPOENA TO PRODUCE DOCUMENTS, INFORMATION, OR OBJECTS
OR TO PERMIT INSPECTION OF PREMISES IN A CIVIL ACTIONTo: Applied Materials, Inc. c/o Corporation Service Company Which Will Do Business in California as
CSC - Lawyers Incorporating Service, 2710 Gateway Oaks Dr., Ste 150N, Sacramento, CA 95833

(Name of person to whom this subpoena is directed)

☒ **Production:** **YOU ARE COMMANDED** to produce at the time, date, and place set forth below the following documents, electronically stored information, or objects, and to permit inspection, copying, testing, or sampling of the material:

Documents and tangible things set forth in the attached Exhibit 1.

Place: JONES DAY, 555 California St., Suite 2600, San
Francisco, CA 94104.1501

Date and Time:

06/15/2019 10:00 am

☐ **Inspection of Premises:** **YOU ARE COMMANDED** to permit entry onto the designated premises, land, or other property possessed or controlled by you at the time, date, and location set forth below, so that the requesting party may inspect, measure, survey, photograph, test, or sample the property or any designated object or operation on it.

Place:

Date and Time:

The following provisions of Fed. R. Civ. P. 45 are attached – Rule 45(c), relating to the place of compliance; Rule 45(d), relating to your protection as a person subject to a subpoena; and Rule 45(e) and (g), relating to your duty to respond to this subpoena and the potential consequences of not doing so.

Date:

6/4/2019

CLERK OF COURT

OR

Signature of Clerk or Deputy Clerk


Attorney's signature

The name, address, e-mail address, and telephone number of the attorney representing (name of party) Micron Technology, Inc., who issues or requests this subpoena, are:

Douglas L. Clark, 4655 Executive Dr., Suite 1500, San Diego CA, 92121 dlclark@jonesday.com, 858.703.3133

Notice to the person who issues or requests this subpoena

If this subpoena commands the production of documents, electronically stored information, or tangible things or the inspection of premises before trial, a notice and a copy of the subpoena must be served on each party in this case before it is served on the person to whom it is directed. Fed. R. Civ. P. 45(a)(4).

Civil Action No. 3:17-CV-06932-MMC

PROOF OF SERVICE*(This section should not be filed with the court unless required by Fed. R. Civ. P. 45.)*

I received this subpoena for *(name of individual and title, if any)* _____
 on *(date)* _____.

☐ I served the subpoena by delivering a copy to the named person as follows: _____

_____ on *(date)* _____; or

☐ I returned the subpoena unexecuted because: _____

Unless the subpoena was issued on behalf of the United States, or one of its officers or agents, I have also
 tendered to the witness the fees for one day's attendance, and the mileage allowed by law, in the amount of
 \$ _____.

My fees are \$ _____ for travel and \$ _____ for services, for a total of \$ 0.00 .

I declare under penalty of perjury that this information is true.

Date: _____

Server's signature

Printed name and title

Server's address

Additional information regarding attempted service, etc.:

Print

Save As...

Add Attachment

Reset

Federal Rule of Civil Procedure 45 (c), (d), (e), and (g) (Effective 12/1/13)**(c) Place of Compliance.**

(1) For a Trial, Hearing, or Deposition. A subpoena may command a person to attend a trial, hearing, or deposition only as follows:

- (A) within 100 miles of where the person resides, is employed, or regularly transacts business in person; or
- (B) within the state where the person resides, is employed, or regularly transacts business in person, if the person
 - (i) is a party or a party's officer; or
 - (ii) is commanded to attend a trial and would not incur substantial expense.

(2) For Other Discovery. A subpoena may command:

- (A) production of documents, electronically stored information, or tangible things at a place within 100 miles of where the person resides, is employed, or regularly transacts business in person; and
- (B) inspection of premises at the premises to be inspected.

(d) Protecting a Person Subject to a Subpoena; Enforcement.

(1) Avoiding Undue Burden or Expense; Sanctions. A party or attorney responsible for issuing and serving a subpoena must take reasonable steps to avoid imposing undue burden or expense on a person subject to the subpoena. The court for the district where compliance is required must enforce this duty and impose an appropriate sanction—which may include lost earnings and reasonable attorney's fees—on a party or attorney who fails to comply.

(2) Command to Produce Materials or Permit Inspection.

(A) *Appearance Not Required.* A person commanded to produce documents, electronically stored information, or tangible things, or to permit the inspection of premises, need not appear in person at the place of production or inspection unless also commanded to appear for a deposition, hearing, or trial.

(B) *Objections.* A person commanded to produce documents or tangible things or to permit inspection may serve on the party or attorney designated in the subpoena a written objection to inspecting, copying, testing, or sampling any or all of the materials or to inspecting the premises—or to producing electronically stored information in the form or forms requested. The objection must be served before the earlier of the time specified for compliance or 14 days after the subpoena is served. If an objection is made, the following rules apply:

- (i) At any time, on notice to the commanded person, the serving party may move the court for the district where compliance is required for an order compelling production or inspection.
- (ii) These acts may be required only as directed in the order, and the order must protect a person who is neither a party nor a party's officer from significant expense resulting from compliance.

(3) Quashing or Modifying a Subpoena.

(A) *When Required.* On timely motion, the court for the district where compliance is required must quash or modify a subpoena that:

- (i) fails to allow a reasonable time to comply;
- (ii) requires a person to comply beyond the geographical limits specified in Rule 45(c);
- (iii) requires disclosure of privileged or other protected matter, if no exception or waiver applies; or
- (iv) subjects a person to undue burden.

(B) *When Permitted.* To protect a person subject to or affected by a subpoena, the court for the district where compliance is required may, on motion, quash or modify the subpoena if it requires:

- (i) disclosing a trade secret or other confidential research, development, or commercial information; or

(ii) disclosing an unretained expert's opinion or information that does not describe specific occurrences in dispute and results from the expert's study that was not requested by a party.

(C) *Specifying Conditions as an Alternative.* In the circumstances described in Rule 45(d)(3)(B), the court may, instead of quashing or modifying a subpoena, order appearance or production under specified conditions if the serving party:

- (i) shows a substantial need for the testimony or material that cannot be otherwise met without undue hardship; and
- (ii) ensures that the subpoenaed person will be reasonably compensated.

(e) Duties in Responding to a Subpoena.

(1) Producing Documents or Electronically Stored Information. These procedures apply to producing documents or electronically stored information:

(A) *Documents.* A person responding to a subpoena to produce documents must produce them as they are kept in the ordinary course of business or must organize and label them to correspond to the categories in the demand.

(B) *Form for Producing Electronically Stored Information Not Specified.* If a subpoena does not specify a form for producing electronically stored information, the person responding must produce it in a form or forms in which it is ordinarily maintained or in a reasonably usable form or forms.

(C) *Electronically Stored Information Produced in Only One Form.* The person responding need not produce the same electronically stored information in more than one form.

(D) *Inaccessible Electronically Stored Information.* The person responding need not provide discovery of electronically stored information from sources that the person identifies as not reasonably accessible because of undue burden or cost. On motion to compel discovery or for a protective order, the person responding must show that the information is not reasonably accessible because of undue burden or cost. If that showing is made, the court may nonetheless order discovery from such sources if the requesting party shows good cause, considering the limitations of Rule 26(b)(2)(C). The court may specify conditions for the discovery.

(2) Claiming Privilege or Protection.

(A) *Information Withheld.* A person withholding subpoenaed information under a claim that it is privileged or subject to protection as trial-preparation material must:

- (i) expressly make the claim; and
- (ii) describe the nature of the withheld documents, communications, or tangible things in a manner that, without revealing information itself privileged or protected, will enable the parties to assess the claim.

(B) *Information Produced.* If information produced in response to a subpoena is subject to a claim of privilege or of protection as trial-preparation material, the person making the claim may notify any party that received the information of the claim and the basis for it. After being notified, a party must promptly return, sequester, or destroy the specified information and any copies it has; must not use or disclose the information until the claim is resolved; must take reasonable steps to retrieve the information if the party disclosed it before being notified; and may promptly present the information under seal to the court for the district where compliance is required for a determination of the claim. The person who produced the information must preserve the information until the claim is resolved.

(g) Contempt.

The court for the district where compliance is required—and also, after a motion is transferred, the issuing court—may hold in contempt a person who, having been served, fails without adequate excuse to obey the subpoena or an order related to it.

EXHIBIT 1 TO APPLIED MATERIALS, INC. SUBPOENA

I. DEFINITIONS

1. “YOU,” “YOUR,” “YOURS,” and “Applied Materials” as used herein, mean and refer to Applied Materials, Inc.—the listed recipient of the attached subpoena—and all persons acting on its behalf.

2. The term “Plaintiff” and “Micron” means Micron Technology, Inc., and any of its affiliates including predecessors in interest, including but not limited to Micron Memory Taiwan (“MMT”), Elpida Memory, Inc. (“Elpida”), and Rexchip Electronics Corporation (“Rexchip”).

3. The term “UMC” mean United Microelectronics Corporation, and any past or present related company, division, subsidiary, parent, affiliate, joint venture, predecessor, successor, or assign, whether U.S. or foreign, whether incorporated or not, and all past or present directors, officers, employees, accountants, consultants, experts, investigators, advisors, representatives, agents and attorneys thereof, and any other person acting on their behalf.

4. The term “UMC Group (USA)” means UMC Group (USA), a UMC affiliate in the Northern District of California. In any request that references “UMC Group (USA),” that entity shall be understood as distinct from “UMC.”

5. The term “Jinhua” means defendant Fujian Jinhua Integrated Circuit Co., Ltd., and any past or present related company, division, subsidiary, parent, affiliate, joint venture, predecessor, successor, or assign, whether U.S. or foreign, whether incorporated or not, and all past or present directors, officers, employees, accountants, consultants, experts, investigators, advisors, representatives, agents and attorneys thereof, and any other person acting on their behalf.

6. The term “Defendants” means UMC and Jinhua.

7. The term “UMC/Jinhua DRAM Project” refers to an agreement entered into between UMC and Jinhua to develop DRAM technologies. As part of this agreement, Jinhua agreed to fund equipment for use by UMC. Any communications to YOU related to DRAM or requests to YOU for equipment to be used for DRAM processing and manufacturing on or after

January 2016 from either UMC or Jinhua should be assumed to be part of the UMC/Jinhua DRAM Project.

8. The term “person” or “persons” means a natural person, corporate or other business, governmental, organizational, or legal entity, unincorporated association, joint venture, sole proprietorship or any other organization, association or individual. The acts of a person are defined to include the acts of an individual, a director, officer, owner, member, employee, agent or attorney acting on the person’s behalf.

9. The terms “related,” “relating to,” “related to,” and “regarding” mean concerning, referring to, describing, summarizing, evidencing, constituting, containing, discussing, identifying or otherwise prepared in connection with the matter.

10. “Include” or “including” means including but not limited to, and should not be read to limit the scope of any discovery Request.

11. The terms “document,” “documents,” and “electronically stored information” have the broadest meanings possible under Rule 34(a) of the Federal Rules of Civil Procedure and include the meanings given the terms “writing” and “recordings” in Federal Rule of Evidence 1001. The terms include, but are not limited to: handwritings, memo pads, typewritings, paintings, photostats, photocopies, drawings, drafts, charts, graphs, other data or data compilations, photographs, electronic documents, images, electronic images, tape recordings, sound recordings, film and every other form of recording, stored in any medium from which information can be obtained either directly or indirectly from any tangible thing; any communications or representations including, but not limited to: letters, words, numbers, symbols, pictures, sounds or combinations thereof; and any stored information or databases, including, but not limited to: information stored in personal information software, risk management information systems, databases, flow charts, word processing software, desktop publishing software and spreadsheets, whether maintained on paper, floppy disks, zip disks, CD-ROMs, DVD-ROMs, flash drives, hard drives, tapes or other magnetic or electronic media or computer storage, or by any other manner. The terms include the originals, or if the originals are

unavailable, duplicates from which information can be obtained or translated. Any copies containing or having attached any alterations, notes, comments or other materials which are not included in the original, or other copies, shall be deemed separate documents or electronically stored information. All produced documents or electronically stored information shall include the original metadata associated with the documents or electronically stored information.

12. The term “identity,” “identify” or “identification” when used with reference to a natural person, means provide the following: his/her full name; his/her current and last known business affiliation, title, and employment position, including a description of duties and responsibilities; his/her current business address or, if that is not known, his/her last known business address; and his/her current residential address or, if that is not known, his/her last known residential address.

13. The term “Request(s)” shall mean one or more of the numerical Requests for Documents to be Produced under Section III, *infra*.

14. All undefined terms should be interpreted using common sense and the Federal Rules of Civil Procedure. This means that words should generally be understood to have their ordinary English language meaning as used in common vernacular. If certain terms have specific or specialized meaning in YOUR industry that make sense in the context of the request, then that specialized meaning should be applied.

15. If the Federal Rules of Civil Procedure provide a specific definition for a term, e.g., “Document,” then that definition is controlling.

16. The date(s) of these Requests should refer, unless otherwise indicated, from January 1, 2016 until present.

II. INSTRUCTIONS

1. Respond separately and completely to each Request.
2. YOU are requested to produce documents as the documents are kept in the usual and ordinary course of business.

3. YOU are requested to produce all documents responsive to these requests that can be located after a reasonably diligent search.

4. If YOU encounter any ambiguities when construing a Request or definition, respond with the matter deemed ambiguous and specify the construction used in responding.

5. If YOU withhold any document, electronically stored information, or thing based on an objection of, including but not limited to—privilege or the work-product doctrine (collectively, “privilege”), scope, burden, prematurity, confidentiality or expense—provide the following: the type of document, electronically stored information, or thing; the general subject matter of the document, electronically stored information, or thing; the creation date of the document, electronically stored information, or thing; and information sufficient to identify the document, electronically stored information, or thing, including, but not limited to the author, addressees, custodian, any other recipient of the document and the relationships of the author, addressee, custodian and any other recipient to each other. If YOU assert a privilege with regard to part of the material contained, disclose the non-privileged material to the fullest extent possible and indicate clearly the portions as to which the privilege is claimed.

6. If YOU withhold any document, electronically stored information, or thing on the grounds that production is unduly burdensome or expensive, describe the reasons that the production is unduly burdensome or expensive.

7. Produce all responsive documents, electronically stored information, or things along with all non-identical drafts and copies, without abbreviation or redaction.

8. In accordance with the Federal Rules of Civil Procedure, these requests are continuing. In the event that YOU (or YOUR attorneys) generate or become aware of any data or documents within the scope of these requests after YOUR responses and/or initial production of data and documents, such additional responsive information shall be timely furnished to Micron’s attorneys.

9. Please complete and sign the attached Certificate of Authenticity of Business Records and return it with the records requested by this subpoena.

III. REQUESTS FOR DOCUMENTS TO BE PRODUCED

1. All documents, including all communications with UMC, UMC Group (USA) or Jinhua, related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
2. Documents sufficient to show all amounts paid by UMC or Jinhua to YOU related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
3. Documents sufficient to show all equipment, tools, wafers, training or other products or services ordered by either UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
4. Documents sufficient to show all equipment, tools, wafers, training or other products or services supplied by YOU to either UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
5. Documents sufficient to show whether the ordered equipment, tools, wafers, training or other products or services in the two prior Requests were conveyed, shipped or otherwise provided to UMC and/or Jinhua.
6. Communications or documents sufficient to show all requirements, configurations or specifications provided to YOU for any tool, equipment or purchase related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
7. Communications or documents sufficient to show all requirements, goals, or specifications for wafers related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
8. To the extent not previously provided, all documents related to any visits between YOU and either UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
9. Documents sufficient to describe any demonstrations conducted by YOU for UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present. These documents should include at a minimum documents to show the purpose for the demonstration, what the demonstration consisted of, those involved in the demonstration, and

YOUR achievement of any goals, including what those goals were and communications related to the same. These demonstrations, include, but are not limited to the live demo carried out from October 3-14, 2016, the OPUS demo, any demo wafer preparations, and Spacer Etch demo.

10. Documents, including all communications regarding any roadmaps or milestones related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.

11. Any recipes provided to YOU by UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present, as well as communications related to recipes.

12. Documents sufficient to show all process work conducted by YOUR process engineers for UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.

13. Any documents containing non-public Micron information provided to YOU from either UMC or Jinhua.

14. All documents referring to Micron provided by either UMC or Jinhua to YOU.

15. All documents referring to Micron provided by YOU to either UMC or Jinhua.

I, _____, CERTIFY AND DECLARE AS FOLLOWS:

1. I am over the age of 18 years and not a party to this action.

2. My business address is:

3. My employment, business, or occupation is:

4. I am the duly authorized Custodian of Records for **Applied Materials, Inc.**, and I have the authority to certify such records.

5. On June ____, 2019, I was personally served with a Subpoena for Production of Business Records in the action entitled *Micron Technology, Inc. v. United Microelectronics Corporation, et al.*, Case No. 3:17-cv-06932-MMC (N.D. Cal.) ("Subpoena").

6. The documents accompanying this affidavit are true copies of the records described in the Subpoena that are in my possession, custody, or control as Custodian of Records.

7. The records were prepared in the ordinary course of business at or near the time of the acts, conditions, or events recorded.

I have delivered all of the records described in the Subpoena that are in my possession, custody or control along with this affidavit to Marcus S. Quintanilla (555 California St., Suite 2600, San Francisco, CA 94104).

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct.

DATED: _____, 2019

CUSTODIAN OF RECORDS

NAI-1507696017v1

Exhibit B

OCTOBER 2020

U.S. Semiconductor Exports to China: Current Policies and Trends

CSET Issue Brief



AUTHOR

Saif M. Khan

Table of Contents

Executive Summary	3
Introduction	6
List-Based Semiconductor Controls.....	7
Wassenaar Arrangement	7
Commerce Control List.....	8
End-Use and End-User Semiconductor Controls.....	11
Entity List	11
Military End-Use and End-User Controls.....	14
Validated End-User List.....	15
Semiconductor Exports and Export Licensing	16
Conclusion	24
Acknowledgments	25
Endnotes	26

Executive Summary

The United States has long used export controls to prevent the proliferation of advanced semiconductors and the inputs necessary to produce them. Semiconductors underpin virtually all aspects of economic and technological development, therefore impacting national and international security. The United States and a small number of democratic allies are the sole producers of advanced semiconductors and many key inputs necessary to manufacture them, creating the option of using export controls as nonproliferation tools. In particular, the United States has recently tightened semiconductor export controls on China, given Beijing's efforts to build a domestic semiconductor industry to answer the demands of "Made in China 2025" and address overreliance of Chinese high-technology industries on imported semiconductors.

Currently, the United States applies multiple types of semiconductor export controls on China. "List-based controls" is a term of art that refers to a list of specific technologies whose export is controlled. "End-use and end-user controls" refer to lists of prohibited end-uses for exported technologies and end-users that cannot receive exports. To export any controlled items, exporters must obtain export licenses—which can be denied by licensing officers.

List-based controls cover exports of various types of semiconductor manufacturing equipment (SME), chips, materials, software, and technical data to all Chinese entities (public and private). Export license decisions are made on a case-by-case basis, historically resulting mostly in approvals.

- Among SME, these controls cover some types of lithography, deposition, ion implanting, testing, and wafer handling tools, but not etching, process control, assembly, and wafer manufacturing tools.
- Among high-end semiconductors, these controls cover field-programmable gate arrays (FPGAs), partly cover central processing units (CPUs), and do not cover graphics processing units (GPUs); it remains unclear whether they cover application-specific integrated circuits (ASICs) customized for artificial intelligence.

- Among materials, these controls cover certain types of masks, resists, consumable gases, wafers, and materials that become wafers and chips.
- Among software, these controls cover software used with or to help produce SME, but not electronic design automation (EDA) software used to design chips.
- Technical data associated with the above technologies is also controlled.
- These controls also require U.S. employers to apply for “deemed export licenses” for Chinese nationals who would access controlled technical data or source code in the United States during their employment.

On top of the list-based controls broadly applied to China, end-use and end-user controls apply additional, more stringent controls on certain Chinese end-uses and end-users—with wider technology coverage and presumption of denial of export licenses.

- Recent “entity listings” cover certain public and private semiconductor-related entities, including chip designers and end-users (like Huawei), various Chinese supercomputing entities, and Chinese chipmakers (like Fujian Jinhua). These controls typically cover all semiconductor technologies.
- Other controls target the Chinese military and civilian Chinese entities supporting the military or engaging in military end-uses, such as Semiconductor Manufacturing International Corporation (SMIC). These controls cover many types of chips (including CPUs, FPGAs, and AI ASICs, but probably not GPUs) and a wide variety of SME.
- However, the United States allows some Chinese semiconductor firms—which follow certain requirements as Validated End-Users (VEUs)—to import otherwise controlled technologies under a general license.

U.S. semiconductor exports to China have increased in recent years because of permissive export licensing policy and declining technology coverage of export controls, but these trends may be changing.

- In particular, exports of SME more than doubled from 2014 to 2019, especially owing to fewer U.S. SME being controlled. Exports of semiconductors also increased in this period, although exports of materials declined.
- However, the United States has recently been tightening semiconductor export controls with stricter licensing policies (including for deemed exports for Chinese nationals), stricter controls on major Chinese entities like Huawei, and expanded military end-use and end-user controls to cover a wider range of Chinese end-uses and end-users, such as SMIC.

Introduction

Semiconductors are essential to the advanced technology powering economic, technological, and military competitiveness.¹ Therefore, policies relating to semiconductors—and the inputs needed to make them²—have major impacts on national and international security.

The United States is now tightening export controls on the inputs China needs to build its semiconductor industry and on the finished semiconductors Chinese high-technology firms and the military currently rely on. This report places these changes in broader context, mapping the current state of U.S. semiconductor export control policy and how policy changes have impacted U.S. semiconductor exports to China in recent years.

The report begins with an overview of the types of semiconductor export controls the United States applies to China. First, the United States uses "list-based controls" on exports of specific semiconductor technologies to all Chinese entities, though it approves most export licenses. These technologies include inputs to semiconductor production—such as semiconductor manufacturing equipment (SME), materials, software, and intellectual property—and the finished semiconductors themselves. The list-based controls also regulate the acquisition of this intellectual property and software by Chinese nationals in the United States. In addition to list-based controls, the United States uses "end-use and end-user controls" on exports for a wider set of technologies, and typically denies export licenses for certain military end-uses and specific end-users. These end-users include Chinese semiconductor firms and semiconductor consumers, such as high-technology Chinese firms, the Chinese military, and civilian entities supporting the military.

The report closes with an analysis of the impacts of U.S. semiconductor export policies on actual U.S. semiconductor exports. It shows that, by 2018, export controls covered fewer semiconductor technologies than before, causing an increase in exports to China, particularly of SME and chips. However, these trends may be reversing, as the United States now applies stricter export licensing policies and expanded end-use and end-user controls on the Chinese military, civilian entities supporting the military, and other major Chinese organizations.

List-Based Semiconductor Controls

List-based controls encompass specific technologies whose export is controlled. The United States maintains a list of controlled technologies called the U.S. Commerce Control List, covering a wide range of semiconductor technologies. The foundation for the U.S. Commerce Control List and allied list-based controls is the internationally agreed upon list produced by the Wassenaar Arrangement. Each country that is a party to the Wassenaar Arrangement bases its export controls on this list.

Wassenaar Arrangement

The Wassenaar Arrangement, a voluntary association with 42 member states, produces a list of dual use technologies and munitions on which signatories should impose export controls. The list specifies more than 150 semiconductor end-products and more than 20 types of SME.³ Member states include those at the leading edge of semiconductor and semiconductor manufacturing equipment production—namely, the United States, the Netherlands,⁴ Japan,⁵ Germany,⁶ and South Korea. Russia is also a member. Each of these states have harmonized their export regulations on semiconductor related technologies with the Wassenaar Arrangement's list. Notably, Taiwan cannot join the Wassenaar Arrangement because of its legal status. However, Taiwan's Bureau of Foreign Trade maintains an export control list based on the Wassenaar Arrangement's list.⁷

The control lists divide technologies into five product groups: two covering physical commodities, and three others covering materials, software, and technical data.⁸ Export controls on technical data and software are associated with the concept of "deemed exports." A deemed export is when a foreign national (one without a U.S. green card or U.S. citizenship) acquires controlled technical data or source code, even if they are in the United States at the time. This acquisition is treated like a normal export. Accordingly, export controls can prevent foreign nationals from working in U.S. industries that otherwise risk imparting controlled technical data or source code.

Commerce Control List

The U.S. Commerce Control List, administered by the Commerce Department's Bureau of Industry and Security (BIS), generally includes the same export controls as the Wassenaar Arrangement, including for semiconductors. The difference is that the U.S. list has additional sections on military-grade versions of the listed technologies and an expanded set of controls for five countries designated as state sponsors of terrorism (North Korea, Cuba, Iran, Sudan, and Syria). A separate U.S. control regime, the International Traffic in Arms Regulation, additionally lists a small number of other military-grade semiconductor export controls.⁹

Table 1 summarizes the U.S. Commerce Control List's export controls on China for certain high-value parts of the semiconductor supply chain.¹⁰ To export these items to any Chinese entity (public or private), exporters must obtain export licenses, which licensing officers grant on a case-by-case basis.¹¹ As required by the Export Control Reform Act of 2018, BIS is currently reviewing whether to amend the export control regulations to make them more restrictive for various emerging and foundational technologies, including semiconductor manufacturing equipment, AI chipsets, quantum computing, microprocessor technology such as systems-on-chips (SoCs) or stacked memory on chip, and advanced computing technology such as memory-centric logic.¹²

Table 1: Key semiconductor items on the Commerce Control List

Category	Item	Export controls applied to China? ¹³	Related technical data controlled for China?
SME ¹⁴	Wafer manufacturing	No	No
	Wafer handling ¹⁵	Yes	Yes
	Ion implanters ¹⁶	Yes (high-current ion implanters for certain dopants)	Yes
	Chemical mechanical planarization	No	No
	Deposition ¹⁷	Yes (some types of chemical & physical vapor deposition for certain materials)	Yes
	Photolithography scanners & steppers ¹⁸	Yes (extreme ultraviolet (EUV) scanners)	Yes
	Imprint lithography ¹⁹	Yes	Yes
	Electron-beam lithography (for chip and mask-making) and laser and ion-beam lithography (for mask-making) ²⁰	Yes	Yes
	Etching	No	No
	Process control	No	No
	Testing ²¹	Yes (for microwave chips and discrete transistors)	No
	Assembly and packaging	No	No
Software	Software to produce or use SME ²²	Yes	No
	EDA software ²³	No	No
Chips ²⁴	CPUs ²⁵	No	Yes
	GPUs ²⁶	No	No
	FPGAs ²⁷	Yes	Yes
	AI ASICs ²⁸	Unclear	Unclear
Materials	Wafers ²⁹	Yes (certain compound semiconductors)	Yes
	Boules and ingots (pre-wafer material) ³⁰	Yes (certain compound semiconductors)	Yes
	Masks ³¹	Yes (EUV masks; other masks for controlled chips e.g. FPGAs)	Yes
	Resists ³²	Yes (for photolithography, positive resists for <193 nm, all resists for <15 nm; and for e-beam and imprint lithography)	Yes
	Etching gas (hydrogen fluoride) ³³	Yes	Yes
	Dopants ³⁴	Yes	Yes

In addition to controlling direct exports from the United States to another country, these export controls can apply to an item “re-exported” from one foreign country (e.g., Japan, South Korea, Germany) to another (e.g. China) in two ways.

First, under the de minimis rule, U.S. export controls apply if an item includes a threshold percentage of U.S.-origin content controlled in the receiving foreign country.³⁵ For example, if the receiving foreign country is China, the de minimis threshold is zero percent for controlled chips³⁶ with the exception of 25 percent for controlled memory chips. For uncontrolled chips, the threshold is also 25 percent. Therefore, the de minimis rule covers a chip fabricated outside the United States if U.S.-origin materials contribute to the applicable percentage in value of the chip. Notably, U.S.-origin intellectual property does not count toward the de minimis rule when incorporated into a tangible item.³⁷ Therefore, when U.S. fabless chip designer Advanced Micro Devices sends controlled U.S.-origin CPU design IP to Taiwan for chip fabrication, U.S. controls do not apply to exports of these chips from Taiwan to China regardless of the percentage of controlled U.S.-origin CPU design IP the fabricated CPU includes.

Second, under the foreign-produced direct product rule, export controls apply if certain highly controlled U.S.-origin content is used to produce the item and if that content is controlled in the receiving foreign country. For example, the foreign-produced direct product rule may cover chips manufactured abroad using highly controlled U.S.-origin SME.³⁸

Both rules are triggered if the receiving foreign country is China and the content is listed in the U.S. Commerce Control List with a “national security” designation, as is the case for nearly all controlled items listed in Table 1.³⁹

End-Use and End-User Semiconductor Controls

In addition to the previously discussed list-based controls, end-use and end-user controls create a stricter layer of controls on certain Chinese end-uses and end-users. Specifically, the United States applies end-user controls on organizations and persons to whom exports of specified items are highly controlled, even if not by list-based controls. It also controls military end-uses of otherwise uncontrolled items, even if private actors perform such end-uses. Various agencies apply end-user lists: the BIS's Entity List,⁴⁰ Denied Persons List,⁴¹ and military end-user controls;⁴² the State Department's list of Debarred Parties;⁴³ and the Treasury Department's list of specially designated nationals.⁴⁴ BIS also maintains a Validated End-User List, including entities subject to less stringent licensing requirements than others. This section focuses on the Entity List, the VEU List, and military end-use and end-user controls, which affect several large consumers of U.S. semiconductor technologies.

Entity List

BIS lists roughly 180 Chinese entities on its Entity List, which are subject to more stringent controls on top of those imposed by the Commerce Control List. It additionally lists foreign affiliates of these entities.⁴⁵ BIS may choose to require an export license for exports to entities on the Entity List for either a subset or all items under BIS's jurisdiction.⁴⁶ BIS's jurisdiction includes any U.S.-origin commodities, software, or related technical data—which includes virtually all semiconductor-related exports—with some exceptions for items normally in the public domain.⁴⁷ Although these entity listings prevent direct U.S. exports to China, they do not expand the scope of re-export rules (the de minimis rule and the foreign-produced direct product rule) applied to entities on the Entity List. Several firms and their domestic and foreign affiliates on the Entity List have particular relevance to the U.S. semiconductor industry. Six of these groups are included in Table 2. For each of them, export controls apply to all items under BIS's jurisdiction: all chips, SME, EDA software, materials, and related intellectual property. The following discussion also provides more detail on the Fujian Jinhua, Huawei, Sugon, and National Supercomputing Center cases, which had significant impacts on the U.S. semiconductor industry.

Table 2: Entity listings significantly impacting the semiconductor industry

Firm and its affiliates	License review policy	Industry segment	Reason for entity listing
Fujian Jinhua Integrated Circuit	Presumption of denial	Memory chip maker	Trade secret theft from U.S. memory chip maker Micron
Huawei Technologies	Presumption of denial	Chip end-users	National security concerns
Sugon	Presumption of denial	CPU and supercomputer developer	National security concerns
China Electronics Technology Group & Chengdu GaStone Technology ⁴⁸	Presumption of denial	Chip design and fabrication	Illicit procurement of technologies for military end-uses
National Supercomputing Centers	Case-by-case basis	Chip end-users	National security concerns over military uses of supercomputers
Firms assisting Chinese government's surveillance of Uyghurs ⁴⁹	Case-by-case basis for specified items, presumption of denial for all others	Chip end-users	Surveillance of Uyghurs in Xinjiang

Fujian Jinhua. In 2018, BIS placed Chinese memory chip maker Fujian Jinhua on the Entity List with presumptive denial of export licenses in response to its alleged theft of trade secrets worth billions of dollars from U.S. memory chip maker Micron Technology.⁵⁰ Fujian Jinhua had just built a \$6 billion plant and was receiving and bringing online SME. The day the United States announced the export ban—which denied Fujian Jinhua access to U.S.-origin SME and materials, among other items—staff from U.S. SME firm Applied Materials “packed up and left,” and engineers from U.S. SME firms KLA-Tencor and Lam Research and Dutch SME firm ASML quickly followed suit.⁵¹ ASML may have obeyed the export ban because it recognized that its photolithography equipment had little value for chip fabrication without complementary SME including deposition, etch, and process control equipment. Anonymous executives of multiple Japanese SME firms including Tokyo Electron said they would not sell to Chinese firms on the U.S. Entity List

out of “fairness” and to prevent U.S. backlash to Japanese attempts to take market share from U.S. competitors.⁵² In 2019, Fujian Jinhua halted operations.⁵³

Huawei. In 2019, BIS placed Huawei on the Entity List with presumptive denial of export licenses.⁵⁴ BIS issued a temporary general license for a narrow set of exports, re-exports, and in-country transfers to Huawei for U.S. telecom carriers with Huawei equipment to maintain their systems.⁵⁵ This license expired in August 2020.⁵⁶ Several U.S. chip firms stopped supplying chips to Huawei. Other U.S. and foreign chip firms work around the ban by manufacturing chips abroad.⁵⁷ U.S. electronic design automation (EDA) software firms are more clearly subject to the export ban, as they directly export to China. Huawei's subsidiary HiSilicon self-designs chips that meet one-fifth of Huawei's chip demand.⁵⁸ Synopsys, a leading U.S. EDA software firm, confirmed it stopped providing software updates and IP to Huawei, preventing Huawei from developing the most advanced designs. A representative of China's top EDA software firm Empyrean Software said, “[w]e would definitely want to help Huawei if we could, but we really do not have that capability[.] It would be like we sold cars, but Huawei came in and asked us to build airplanes or even rockets for them.”⁵⁹ Additionally, the entity listing—because it did not expand the scope of controlled re-exports—left Huawei the option to obtain chips manufactured by fabs (such as TSMC) outside the United States. To close this loophole, BIS added more stringent re-export controls specific to Huawei in 2020, complementing the existing re-export controls broadly applicable to exports to China. Specifically, the new re-export rules prevent Huawei from obtaining chips manufactured by any fabs in the world using U.S. SME.⁶⁰ Given U.S.-China trade tensions, Huawei had been stockpiling U.S. components for a year before the export ban,⁶¹ and its phones now include fewer U.S. components.⁶² But in light of the new re-export controls, Huawei may run out of chips.

Sugon. In 2016, Chinese supercomputer developer Sugon partnered with U.S. chip firm Advanced Micro Devices to design chips using AMD's x86 CPU design. After AMD faced sharp revenue declines in 2015 to 2016, the deal brought a much-needed infusion of cash and the promise of ongoing licensing revenues for chips developed under the joint venture.⁶³ In 2019, BIS placed Sugon and related entities on the Entity List with presumptive denial of export licenses, forcing AMD to withdraw from the joint venture.⁶⁴ It is unclear whether Sugon can continue to fabricate the current version of the chip or design new versions without AMD's technical help. Some claim this joint

venture gave China know-how and a foothold in the x86 market, but AMD claims the licensed designs were not state of the art.⁶⁵ Others suggest AMD shared little IP,⁶⁶ or that other Chinese entities had already acquired this know-how.⁶⁷

National Supercomputing Centers. In 2015, BIS placed several of China's National Supercomputing Centers on the Entity List with presumptive denial of export licenses over national security concerns. These concerns arose from the development of the world's most powerful supercomputer, Sunway TaihuLight, using Intel Xeon CPUs.⁶⁸ But this export ban backfired. Without access to Intel's Xeon CPUs, these firms used domestically designed Sunway SW26010 chips instead, and from 2016 to 2018 TaihuLight was the world's most powerful supercomputer anyway.⁶⁹

Military End-Use and End-User Controls

The United States applies strict export controls for Chinese military end-uses and end-users beyond those imposed by the Commerce Control List on all Chinese entities. Although such controls have long existed, BIS expanded them in 2020.⁷⁰ Today, an export to any Chinese end-user is controlled if it is for the use (i.e., operation, installation, maintenance, repair, overhaul, or refurbishment), development, or production of a military item; or if the export supports or contributes to those functions. Exports are further controlled for Chinese military end-users, which include armed forces, police, intelligence services, and "any person or entity whose actions or functions are intended to support 'military end uses.'" The latter policy is meant to address China's "military-civil fusion" initiatives.⁷¹

Military end-user and end-user controls apply only to the export of certain items listed on the Commerce Control List not otherwise controlled when exported to China; the new rules expand these items to cover a wide swath of semiconductor technologies, including various logic chips (including CPUs, FPGAs, and AI ASICs, but probably not GPUs) meeting performance thresholds, memory chips meeting storage thresholds, a wider variety of SME than those listed in Table 1, and other semiconductor technologies.⁷² Additionally, license applications for any of the controlled exports are subject to a presumption of denial.⁷³ These requirements impose new controls on SME purchased by private Chinese chipmakers selling chips to the Chinese military. For example, in September 2020, the U.S. government notified U.S. SME firms that exports to China's leading chipmaker, Semiconductor

Manufacturing International Corporation (SMIC), require an export license, because it sells chips to the military.⁷⁴

Validated End-User List

VEUs are entities who have gone through a certification process and are allowed to receive certain U.S. exports under a general authorization, rather than under multiple individual export licenses.⁷⁵ Except for Boeing and General Electric, all other firms on the VEU List are semiconductor firms. These firms include Chinese affiliates of the U.S. semiconductor firms AMD, Intel, Applied Materials, and Lam Research, as well as the South Korean semiconductor firms Samsung and SK Hynix. The rest are Chinese semiconductor firms, including one SME-maker, AMEC, and two Chinese chipmakers, Huahong Grace and CSMC. SMIC obtained VEU status in 2007, but in 2016, the United States removed SMIC from its VEU list at SMIC's request.⁷⁶ The United States requires VEUs to follow certain rules to maintain their status. In 2016, SMIC likely either began collaborating with the Chinese government, or planned to, in a way that would violate its VEU status and therefore requested removal.

Semiconductor Exports and Export Licensing

Despite export controls covering many critical semiconductor technologies, the United States continues to increase semiconductor technology exports to China, either because it does not export control these items or because it often grants export licenses. Although U.S. trade has remained stable as a whole in recent years, exports of semiconductors and SME have increased. This trend is driven by a decline in the scope of controlled semiconductor technologies and because of permissive export licensing policies. Meanwhile, exports of materials used in semiconductor fabrication have decreased.

Total U.S. exports to China remained stable through 2018, with a dropoff in 2019 in the midst of U.S.-China trade tensions (Figure 1). The vast majority of exports are not impacted by export control laws. In 2019, over 98 percent of all U.S. exports to China were not controlled. These numbers do not include license denials and exports forgone due to expected license denials or regulatory burdens of the export license application process.

Figure 1: Total U.S. exports to China



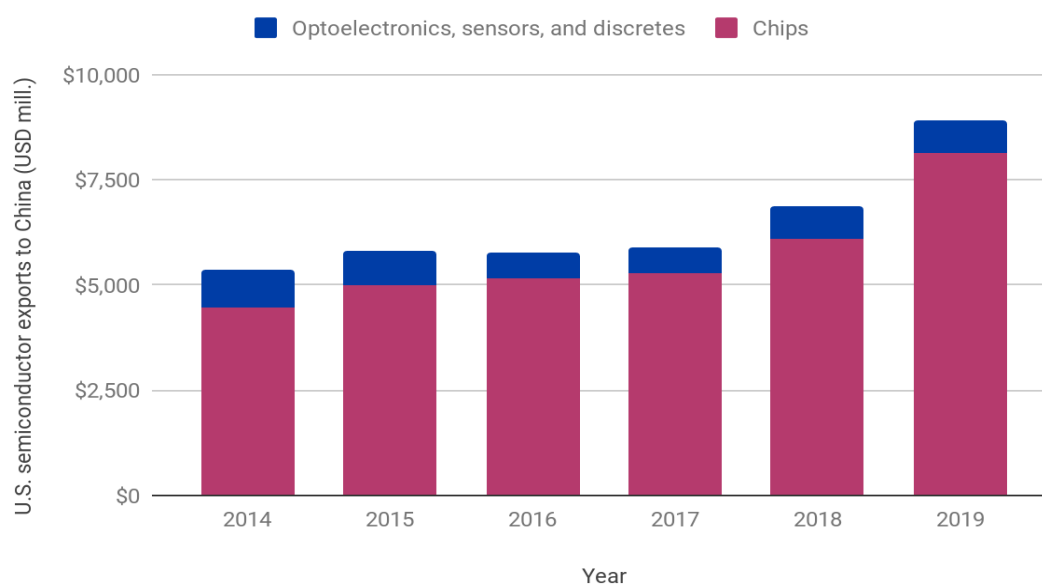
Note: Dollar values are nominal (not inflation-adjusted).

Sources: Bureau of Industry and Security, Asia Analysis, 2014–2019 China reports, <https://www.bis.doc.gov/index.php/statistical-reports/country-analysis/asia>.

By comparison, semiconductor exports to China have risen rapidly (Figures 2 through 4). Although exports of materials declined, exports of semiconductors and SME increased rapidly. One possible explanation is that Chinese firms were stockpiling chips and SME in preparation for possible future U.S. export bans.⁷⁷ Another is that China was rapidly expanding its technological base. For example, the Chinese government is subsidizing SME purchases in excess of fab capacity, suggesting a goal to rapidly expand capacity.⁷⁸ To an increasing degree, these exports include refurbished SME.⁷⁹ Decreasing coverage of export controls may have played a role, including removal of certain SME from the Commerce Control List in 2016, as well as loosened controls on military-grade semiconductor technologies in 2014.⁸⁰

Unfortunately, export data are lacking for other semiconductor sectors. Exports of IP—such as U.S. chip designs outsourced for fabrication at foreign fabs—are not counted in U.S. trade statistics.⁸¹ EDA software is also difficult to capture, especially if delivered as cloud services.

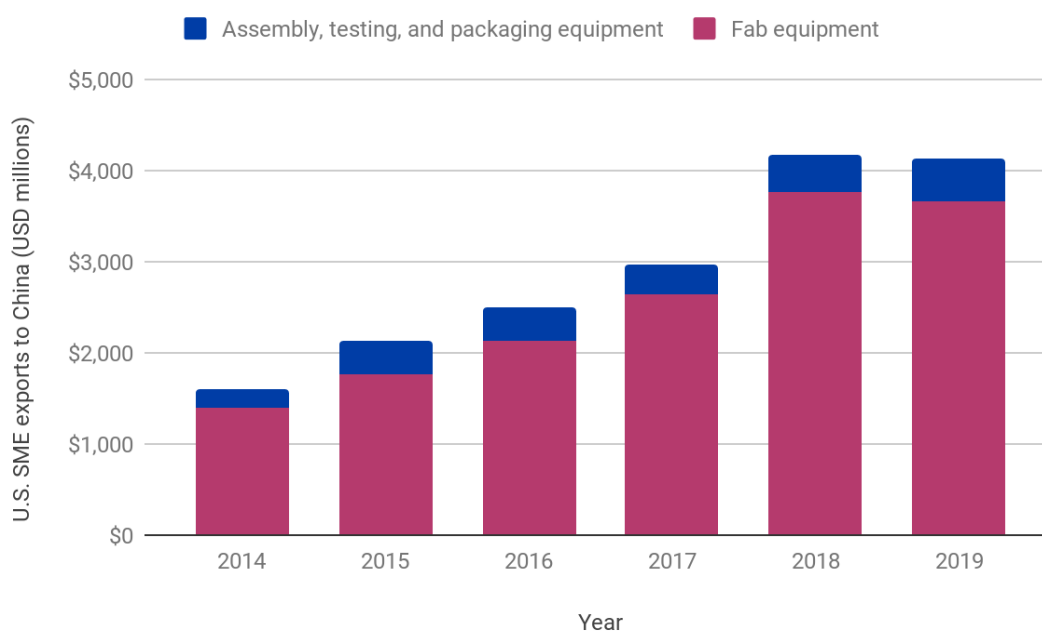
Figure 2: U.S. semiconductor exports to China



Note: Dollar values are nominal (not inflation-adjusted).

Source: U.S. Census export data, <https://dataweb.usitc.gov/>.⁸²

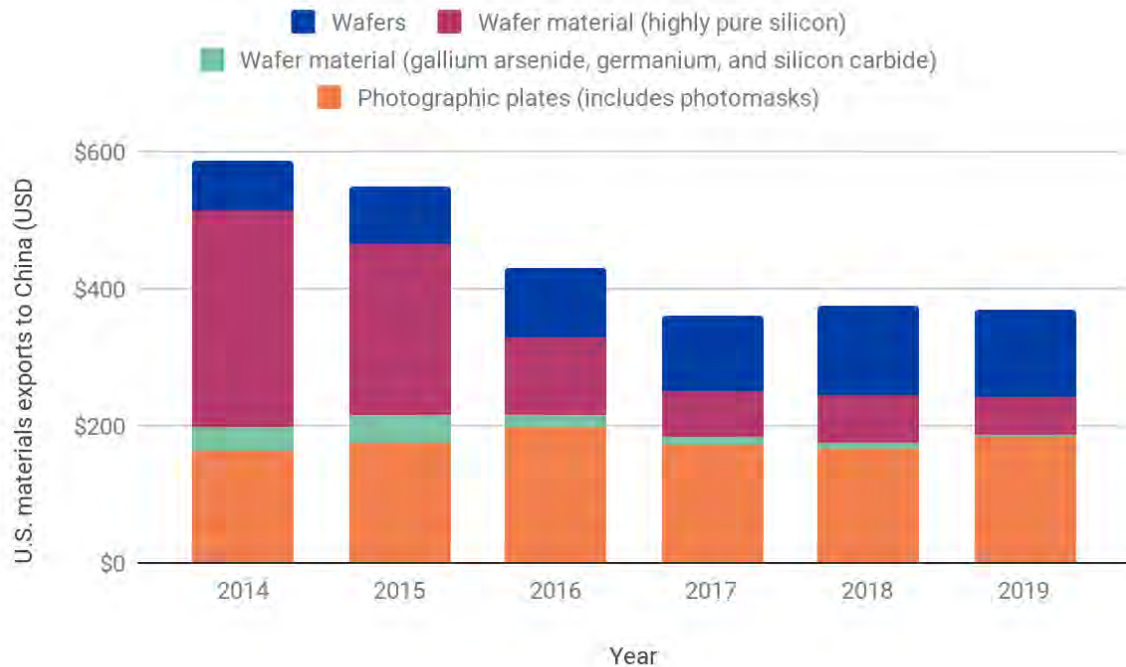
Figure 3: U.S. SME exports to China



Note: Dollar values are nominal (not inflation-adjusted).

Source: U.S. Census export data, <https://dataweb.usitc.gov/>.⁸³

Figure 4: U.S. materials exports to China

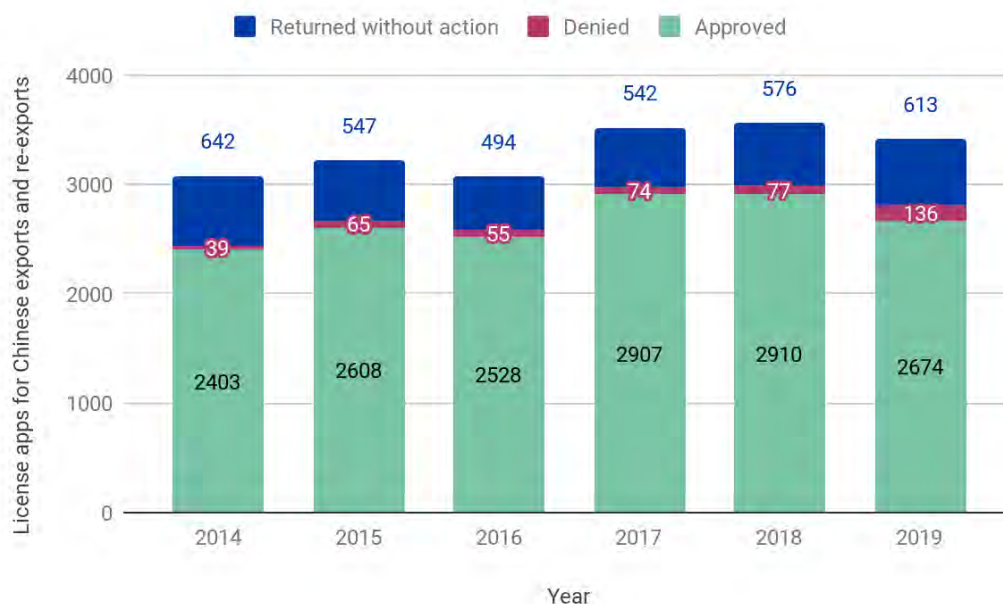


Note: Dollar values are nominal (not inflation-adjusted).

Source: U.S. Census export data, <https://dataweb.usitc.gov/>.⁸⁴

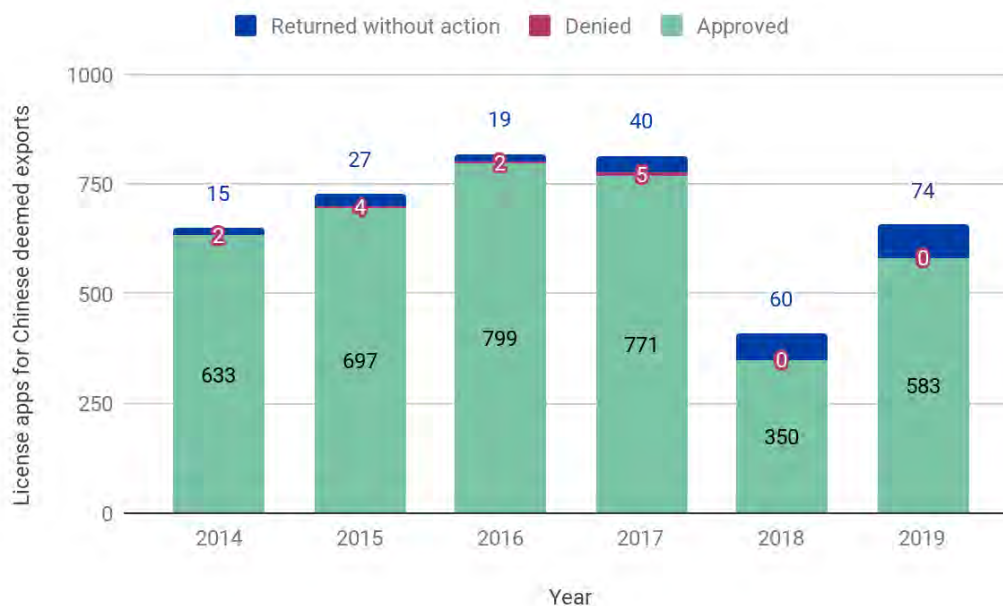
The Bureau of Industry and Security publishes license application outcomes for Chinese exports, re-exports, and deemed exports (Figures 5 and 6). Export and re-export license applications were approved, denied, and returned without action (RWA) at stable rates between 2014 and 2019, except for an uptick in denials in 2019.⁸⁵ During this period, export and re-export license approvals took about three weeks on average for all countries, and four to five weeks on average for China between 2014 and 2018 and nearly seven weeks in 2019.⁸⁶ By comparison, in 2018, deemed export applications for Chinese nationals declined precipitously and RWA decisions increased, with a partial recovery in 2019. (Recall, a U.S. employer must apply for a deemed export license for a foreign national who lacks a U.S. green card or U.S. citizenship and who would access controlled technical data or source code in the United States during their employment.) Deemed export applications for nationals of other countries did not experience the same decline. As a result, Chinese nationals comprised only 35 percent of approvals in 2018, compared to 60 percent in the previous five years. By 2019, approvals sometimes took six to eight months.⁸⁷

Figure 5: U.S. license applications for exports and re-exports to China



Source: Bureau of Industry and Security, Asia Analysis, 2014–2019 China reports, <https://www.bis.doc.gov/index.php/statistical-reports/country-analysis/asia>.

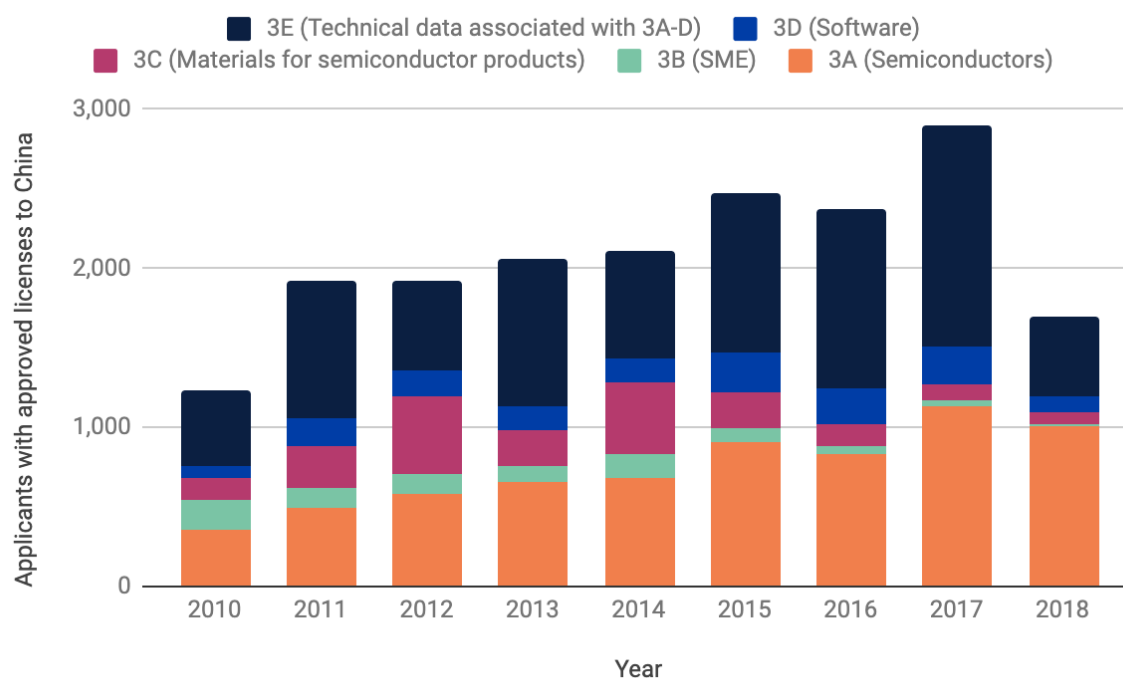
Figure 6: U.S. deemed export license applications for Chinese nationals



Source: Bureau of Industry and Security, Asia Analysis, 2014–2019 China reports, <https://www.bis.doc.gov/index.php/statistical-reports/country-analysis/asia>.

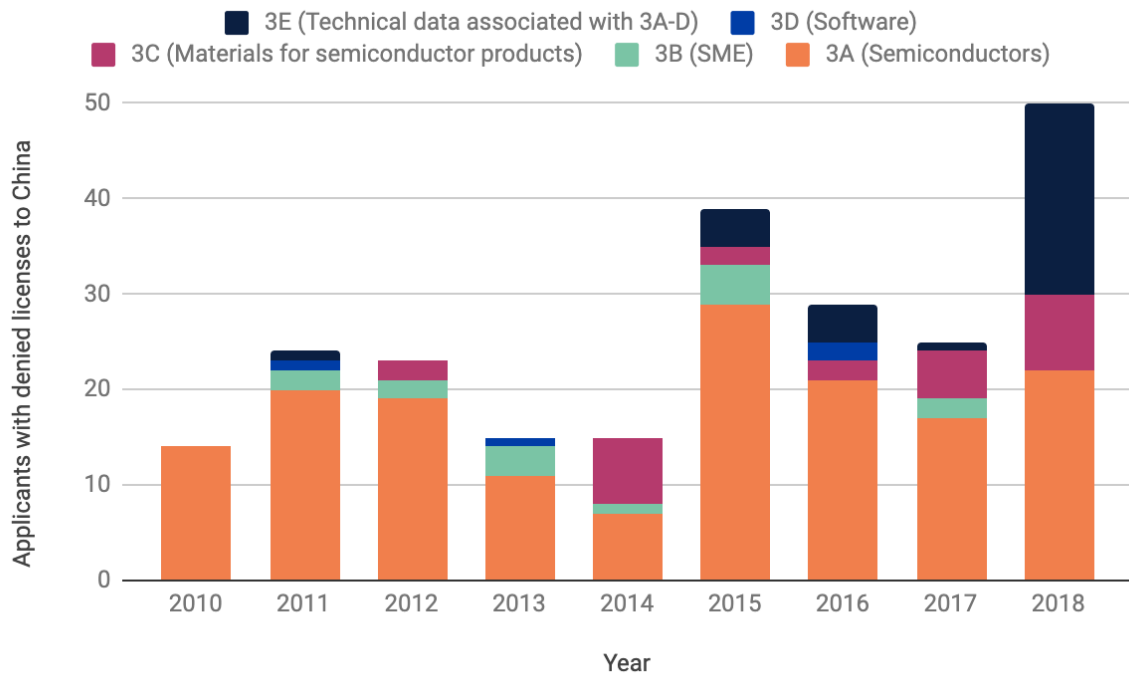
In response to a Freedom of Information Act request, BIS disclosed more detailed export licensing data by technology categorization and destination country between 2010 and 2018 (Figures 7 and 8). This data aggregates export, re-export, and deemed export licenses applications. The results paint a similar picture for the semiconductor industry, with the majority of the 2018 decline in semiconductor license applications for China associated with semiconductor technical data (category 3E in figures 7 and 8), which include deemed export applications.⁸⁸ The upper bound for Chinese-national high-skill technical semiconductor and related industry workers currently working in the United States is approximately 6,000. Deemed export licensing delays have reportedly disrupted hundreds of jobs at U.S. semiconductor firms, including Intel, Qualcomm, and GlobalFoundries.⁸⁹

Figure 7: Approved U.S. semiconductor license applications for Chinese exports, re-exports, and deemed exports



Source: Bureau of Industry and Security, export licensing statistics acquired using FOIA request and published by The Information, <https://www.theinformation.com/tech-exports>.⁹⁰

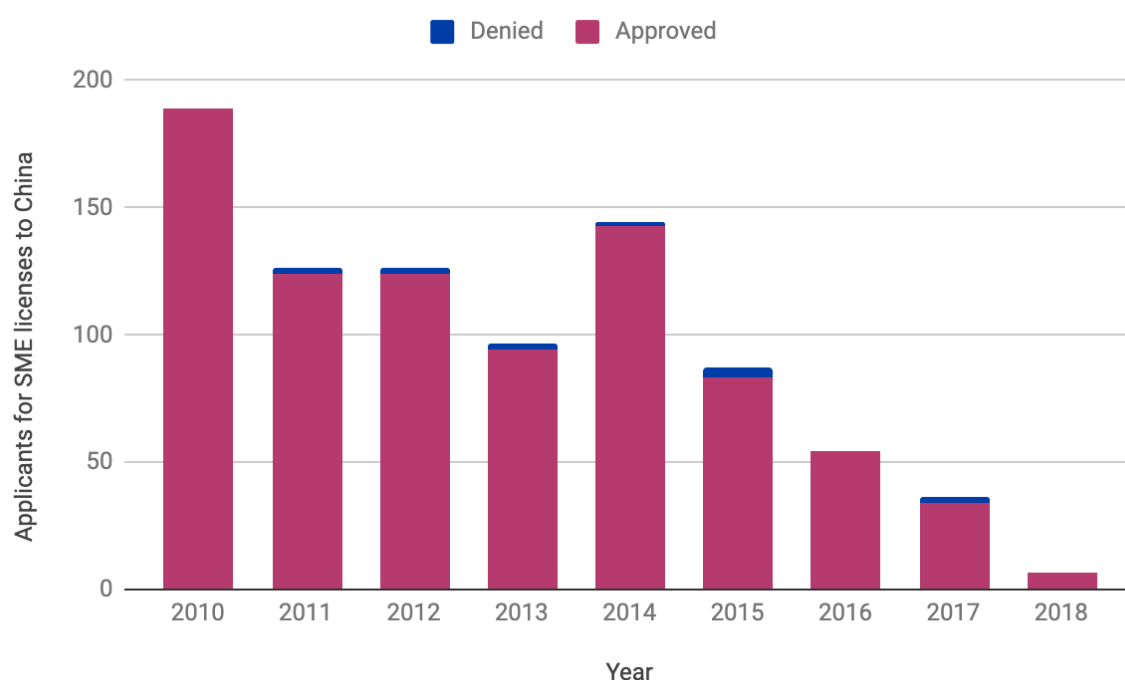
Figure 8: Denied U.S. semiconductor license applications for Chinese exports, re-exports, and deemed exports



Source: Bureau of Industry and Security, export licensing statistics acquired using FOIA request and published by The Information, <https://www.theinformation.com/tech-exports>.

SME export licensing policy became more permissive until 2018. Historically, the U.S. government has often granted export licenses. A 2002 U.S. Government Accountability Office report found that U.S. export-licensing policy for SME had been “unclear and inconsistent”; the United States approved most SME licenses, but “aimed at keeping China at least two generations (about 3 to 4 years) behind global state-of-the-art semiconductor manufacturing capabilities.”⁹¹ By 2018, SME license applications notably dropped, suggesting export controls covered almost no SME exports. In 2018, only seven SME license applications were filed and all were approved (Figure 9).⁹² The most expensive SME, photolithography equipment, remains on the Commerce Control List, but U.S. firms sell little of it. Anisotropic dry etching equipment, which U.S. firms do sell, was removed from the Commerce Control List in 2016,⁹³ coinciding with the drop in SME license applications. This explanation is consistent with the data in Figure 3 showing rapidly increasing SME exports to China since 2016.

Figure 9: U.S. semiconductor license applications for SME exports to China



Source: Bureau of Industry and Security, export licensing statistics acquired using FOIA request and published by The Information, <https://www.theinformation.com/tech-exports>.

Recently, export controls and export licensing policy for SME exports have become more strict. First, in 2018, Chinese fab SMIC purchased ASML's EUV photolithography equipment, which is used to fabricate chips at the leading 7 nm and 5 nm nodes.⁹⁴ ASML claimed it obtained the necessary export licenses, yet given backlogs, the equipment did not ship and the export license expired.⁹⁵ ASML's equipment incorporates U.S.-origin components and intellectual property. Under pressure from the United States, the Dutch government did not renew the export license.⁹⁶ Second, in 2020, BIS introduced stricter military end-use and end-user export controls and repealed civilian use exceptions for China. These rules require licenses for SME exports to Chinese chipmakers serving the military—such as SMIC—or for SME previously subject to a civilian use license exemption. License applications required by these rules are subject to a presumption of denial.⁹⁷ Third, BIS is considering new export controls on SME.⁹⁸ Fourth, in September 2020, Congress introduced a bill to tighten multilateral export controls on SME.⁹⁹

Conclusion

The United States has historically controlled many exports of semiconductor technologies to China, given their strategic importance. China's rise and efforts to build up domestic semiconductor production have prompted the United States to further tighten these export controls.

Today, the United States controls exports of specific semiconductor technologies—including certain semiconductor manufacturing equipment, high-end chips, materials, software, and related technical data—to all Chinese entities. It also controls the acquisition of technical data or source code by Chinese nationals on U.S. soil. For these controls, the United States historically approved most export licenses.

On top of these controls, the United States restricts exports of a wider set of technologies to certain end-users and for certain end-uses in China—including many U.S. semiconductor technology consumers such as Huawei, China's supercomputing centers, certain Chinese chipmakers, and military end-uses and end-users. For these controls, the United States typically denies export licenses.

On balance, through 2018, export controls on semiconductor technology had relaxed, resulting in an expansion of exports to China, particularly of SME and chips. However, the United States has recently tightened export licensing policies and applied stricter controls on military end-uses and end-users, as well as on other major Chinese entities.

Going forward, the vital importance of semiconductors in national and international security will continue to place them at the center of the U.S. export control system.

Acknowledgments

For helpful discussions, comments, and input, great thanks go to Carrick Flynn, Alex Friedland, Patrick Maloney, Alexander Mann, Igor Mikolic-Torreira, Dewey Murdick, Alexandra Vreeman, and Lynne Weil. The author is solely responsible for all mistakes.



© 2020 by the Center for Security and Emerging Technology. This work is licensed under a Creative Commons Attribution-Non Commercial 4.0 International License.

To view a copy of this license, visit
<https://creativecommons.org/licenses/by-nc/4.0/>.

Endnotes

¹ Semiconductors include several categories. The most important category is computer chips, which include logic chips (42 percent of sales in 2019, counting microprocessors, microcontrollers, and other logic chips), memory chips (26 percent), and analog chips (13 percent). Others include optoelectronics (10 percent), sensors (three percent), and discretes (six percent). “WSTS Semiconductor Market Forecast Spring 2020,” World Semiconductor Trade Statistics, June 9, 2020,

https://www.wsts.org/esraCMS/extension/media/f/WST/4622/WSTS_nr-2020_05.pdf.

² These inputs include electronic design automation software and intellectual property used to design semiconductors; materials that become semiconductors; and the semiconductor manufacturing equipment used to manufacture, assemble, test, and package semiconductors.

³ “Measuring distortions in international markets: The semiconductor value chain” (Paris: Organisation for Economic Cooperation and Development, December 12, 2019), 39, <https://doi.org/10.1787/8fe4491d-en>.

⁴ The Netherlands’ revenue service Belastingdienst implements these export controls. “Netherlands Export Control Information,” Bureau of Industry and Security, accessed July 13, 2020, <https://www.bis.doc.gov/index.php/all-articles/220-eco-country-pages/1048-netherlands-export-control-information>.

⁵ Japan’s Ministry of Economy, Trade and Industry implements these export controls. “Japan Export Control Information,” Bureau of Industry and Security, accessed July 13, 2020, <https://www.bis.doc.gov/index.php/enforcement/oea?id=1156>.

⁶ Germany’s Federal Office of Economics and Export Control implements these export controls. “Germany Export Control Information,” Bureau of Industry and Security, accessed July 13, 2020, <https://www.bis.doc.gov/index.php/all-articles/220-eco-country-pages/1041-germany-export-control-information>.

⁷ “Taiwan Export Control Information,” Bureau of Industry and Security, accessed July 13, 2020, <https://www.bis.doc.gov/index.php/all-articles/220-eco-country-pages/1155-taiwan-export-control-information>.

⁸ “Commerce Control List (CCL),” Bureau of Industry and Security, accessed July 13, 2020, <https://www.bis.doc.gov/index.php/regulations/commerce-control-list-ccl>

⁹ 22 C.F.R. § 121.1 Category XI (2019).

¹⁰ Table 1 focuses on items in Category 3 of the Commerce Control List, which covers electronics design, development, and production, but also includes some items from Category 1 (Materials, Chemicals, Microorganisms and Toxins), 2 (Materials Processing), and 4 (Computers).

¹¹ Depending on the type of technology, authority over the licensing decision is assigned to BIS, the Department of Defense’s Defense Technology Security Administration (DTSA), or the Department of State. DTSA is typically more likely to deny licenses than BIS and State.

¹² 83 Fed. Reg. 58,201 (Nov. 19, 2018) (revising 15 C.F.R. § 744), <https://www.federalregister.gov/documents/2018/11/19/2018-25221/review-of->

[controls-for-certain-emerging-technologies](#); 85 Fed. Reg. 52,934 (Aug. 27, 2020) (revising 15 C.F.R. § 742, 774),

<https://www.federalregister.gov/documents/2020/08/27/2020-18910/identification-and-review-of-controls-for-certain-foundational-technologies>. For examples of potential restrictions, see Alexandra Alper, “U.S. finalizing rules to limit sensitive tech exports to China, others,” *Reuters*, December 17, 2019, <https://www.reuters.com/article/us-usa-tech-china-exclusive/exclusive-us-finalizing-rules-to-limit-sensitive-tech-exports-to-china-others-idUSKBN1YL1B8>.

¹³ Many of the export controls in the Commerce Control List are applied to countries with a “national security” designation. There are two “national security” country lists—NS–1 and NS–2—and China is included in both. A wider array of technologies is controlled for a small number of countries that have an “anti-terrorism” designation (which does not include China). ECCNs 3A991–999, 3B991–992, 3C992, 3D991, and 3E991. For the country lists, see 15 C.F.R. Supplement No. 1 to § 738,

<https://www.bis.doc.gov/index.php/documents/regulations-docs/federal-register-notices/federal-register-2014/1033-738-supp-1/file>.

¹⁴ For more information on the role of different types of SME, see John VerWey, *The Health and Competitiveness of the U.S. Semiconductor Manufacturing Equipment Industry* (Washington, DC: U.S. International Trade Commission, July 2019), 3, https://www.usitc.gov/publications/332/working_papers/id_058_the_health_and_competitiveness_of_the_sme_industry_final_070219checked.pdf. SME specially designed for making ASICs designed for military items and FPGAs programmed for military items are more broadly controlled. ECCN 3B611 (NS–1 countries).

¹⁵ ECCN 3B001.e (NS–2 countries); ECCN 3E001 (NS–1 countries).

¹⁶ ECCN 3B001.b, 3B001.e, and 2B005.b, (NS–2 countries); ECCN 3E001, 2E001, and 2E002 (NS–1 countries).

¹⁷ ECCN 3B001.a, 3B001.e, 2B005.a, and 2B005.c-f (NS–2 countries); ECCN 3E001, 2E001, 2E002, and 2E003.f (NS–1 countries).

¹⁸ ECCN 3B001.f.1 (NS–2 countries); ECCN 3E001 (NS–1 countries). EUV scanners are the most advanced photolithography tools, necessary for fabricating chips at the 5 nm node. Argon fluoride (ArF) immersion scanners are the next most advanced. EUV or ArF immersion scanners are necessary for fabricating chips between the 45 nm and 7 nm nodes. Robert Castellano, “Canon’s Nanoimprint Lithography: A Chink In ASML Holding’s Armor,” *Seeking Alpha*, March 19, 2019, <https://seekingalpha.com/article/4249762-canons-nanoimprint-lithography-chink-asml-holdings-armor>. ECCN 3B001.f.1.b controls photolithography tools “[c]apable of producing a pattern with a ‘Minimum Resolvable Feature size’ (MRF) of 45 nm or less.” At first glance, this clause appears to cover ArF immersion scanners. However, a technical note defines MRF as (an exposure light source wavelength in nm) x (K factor = 0.35) / numerical aperture. All ArF immersion scanners have a 193 nm light source and the most advanced ArF immersion scanners reach a numerical aperture of 1.35. ASML, “TWINSCAN NXT:2000i,” accessed September 3, 2020, <https://www.asml.com/en/products/duv-lithography-systems/twinscan-nxt2000i>. These values result in an MRF of 50 nm, avoiding controls.

¹⁹ ECCN 3B001.f.2 (NS–2 countries); ECCN 3E001 (NS–1 countries).

²⁰ ECCN 3B001.f.3 (NS–2 countries); ECCN 3E001 (NS–1 countries).

²¹ ECCN 3B002 (NS–2 countries); ECCN 3E001 (NS–1 countries).

²² ECCN 3D001–005 (NS–1 countries). Military-use software is more broadly controlled. ECCN 3D611 (NS–1 countries).

²³ ECCN 3D003 (NS–1 countries) is not interpreted as covering EDA software. See also “EDAC urges U.S. to ease export rules,” *EETimes*, July 19, 2004, https://www.eetimes.com/document.asp?doc_id=1217839 (discussing past arguments on the applicability of ECCN 3D003 to EDA software). See also ECCN 3E002 (NS–1 countries).

²⁴ ASICs designed for military items and FPGAs programmed for military items are more broadly controlled. ASICs designed for less-sensitive military items are controlled under ECCN 3A611.f and 3A611.y.14 (NS–1 countries) while ASICs and FPGAs designed for more-sensitive military items are controlled by the U.S. International Traffic in Arms Regulation (ITAR) export control regime under the U.S. Munitions List. 22 C.F.R. § 121.1 Category XI(c)(1) (2019). Additionally, ECCN 3A001.a.3 covers (though not for civilian uses) microprocessors using compound semiconductors like gallium arsenide rather than elemental semiconductors like silicon. Therefore, Table 1 only reflects export control coverage for chips with elemental semiconductors like silicon, which is used in AI-relevant chips. Finally, the Commerce Control List also lists a large number of semiconductors in addition to the key items listed in Table 1.

²⁵ ECCN 3A991.a (AT countries) does not include China; ECCN 3E002 (NS–1 countries); “AMD Regulatory Trade Compliance,” AMD, Accessed July 13, 2020, <https://www.amd.com/en/corporate-responsibility/trade-compliance>.

²⁶ ECCN 3A991.a (AT countries) does not include China.

²⁷ ECCN 3A001.a.7 (NS–2 countries); ECCN 3E001 (NS–1 countries). A broader range of FPGAs are controlled for countries, not including China, with an “anti-terrorism” designation. ECCN 3A991.d (AT countries).

²⁸ ECCN 3A001.a.9 (NS–2 countries) lists “neural network integrated circuits,” which the U.S. Commerce Control List has listed at least as far back as 2003. Revision of Export Controls for General Purpose Microprocessors, 68 Fed. Reg. 1796 (Jan. 14, 2003) (revising 15 C.F.R. § 744), <https://www.federalregister.gov/documents/2003/01/14/03-714/revision-of-export-controls-for-general-purpose-microprocessor>. See ECCN 3E001 (NS–1 countries) for related technical data controls. However, neural network integrated circuits are likely not interpreted as covering AI ASICs. ECCN 4A004.b (NS–2 countries) lists “neural computers” which are defined as “computational devices designed or modified to mimic the behaviour of a neuron or a collection of neurons, i.e., computational devices which are distinguished by their hardware capability to modulate the weights and numbers of the interconnections of a multiplicity of computational components based on previous data.” It is unclear whether this category covers any AI ASICs. See ECCN 4E001 (NS–1 countries) for related technical data controls. For more discussion, see Roszel C. Thomsen II, “Artificial Intelligence and Export Controls: Conceivable, But Counterproductive?,” *Journal of Internet Law* 22, no. 5 (November 2018): 16, <https://t-b.com/wp-content/uploads/2019/01/AI-and-Export-Controls-Journal-of-Internet-Law-Article.pdf>; Chris Timura, Sarah Banco, and Charlotte

Bernard, "Practical Guidance On Managing New Foreign Investment Review Requirements and Export Controls on Emerging Technologies," Association of Corporate Counsel, July 10, 2019, 15, <https://www.acc.com/sites/default/files/2019-07/7.10.19%20Slides.pdf>.

²⁹ ECCN 3C001 and 3C006 (NS-2 countries); ECCN 3E001 (NS-1 countries).

³⁰ ECCN 3C005 (NS-2 countries); ECCN 3E001 (NS-1 countries).

³¹ ECCN 3B001.g-j (NS-2 countries); ECCN 3E001 (NS-1 countries). Throughout, the term “mask” is intended to include photomasks, reticles, and stamps. Photomasks and reticles are used in photolithography. A photomask’s pattern has a 1:1 correspondence to a desired wafer pattern, while a reticle’s pattern corresponds to only part of a desired wafer pattern. Therefore, the reticle must be moved relative to the wafer to transfer the reticle’s pattern multiple times to create a repeating pattern on the wafer. A stamp is similar to a photomask, except it is used for imprint lithography rather than photolithography.

³² ECCN 3C002 (NS-2 countries); ECCN 3E001 (NS-1 countries).

³³ ECCN 1C350.d.14 (CB-2 countries); ECCN 1E350 and 1E351 (CB-2 countries).

³⁴ ECCN 3C003-004 (NS-2 countries); ECCN 3E001 (NS-1 countries). These materials include certain compounds having organic and inorganic materials, and hydrides of phosphorus, arsenic, or antimony.

³⁵ The U.S. origin content counts toward the threshold percentage if the item is a (1) non-U.S.-made tangible item that “incorporates” the content, where that content is a controlled U.S.-origin tangible item, (2) non-U.S.-made tangible item that is “bundled” with the content, where that content is controlled U.S.-origin software, (3) non-U.S.-made software that “incorporates” the content, where that content is controlled U.S.-origin software, or (4) non-U.S.-made technical data that is “commingled with or drawn from” the content, where that content is controlled U.S.-origin technical data. 15 C.F.R. § 734.4 (2019); 15 C.F.R. Supplement No. 2 to § 734 (2019); Bureau of Industry and Security, “De minimis Rules and Guidelines,” November 5, 2019, <https://www.bis.doc.gov/index.php/documents/pdfs/1382-de-minimis-guidance/file>.

³⁶ These chips are listed under ECCN 3A001 (NS-2 countries) and 3A611 (NS-1 countries).

³⁷ Bureau of Industry and Security, "De minimis Rules."

³⁸ Because regulations do not define the term “direct product,” it is difficult to make a definitive judgment as to whether the foreign-produced ruled direct produce applies in certain cases. 15 C.F.R. § 736.2(b)(3) (2019).

³⁹ Other designations could also capture China.

⁴⁰ The Wassenaar Arrangement does not include an entity list. However, many other Wassenaar Arrangement members maintain similar lists. Japan, “End User List,” <https://www.meti.go.jp/press/2017/05/20170524001/20170524001-1.pdf>.

Taiwan, "Strategic high-tech goods export entity management list" [我國戰略性高科技貨品出口實體管理名單],

<https://ekm101.trade.gov.tw/cfinder/connector?command=Proxy&type=Files¤tFolder=%2F&fileName=1081125%E6%88%91%E5%9C%8B%E6%88%B0%E7%95%A5%E6%80%A7%E9%AB%98%E7%A7%91%E6%8A%80%E8%B2%A8%E5%93%81%E5%87%BA%E5%8F%A3%E5%AF%A6%E9%AB%94%E7%AE%A1%E7%90%86%E5%90%8D%E5%>

[96%AE.pdf&cache=31536000](#); South Korea, "Denial List,"

<https://www.yestrade.go.kr/common/common.do?jPath=/ja/jaEa081C#>.

⁴¹ "Denied Persons List," U.S. Department of Commerce Bureau of Industry and Security, accessed July 13, 2020, <https://www.bis.doc.gov/index.php/policy-guidance/lists-of-parties-of-concern/denied-persons-list>.

⁴² Expansion of Export, Reexport, and Transfer (in-Country) Controls for Military End Use or Military End Users in the People's Republic of China, Russia, or Venezuela, 85 Fed. Reg. 23,459 (April 28, 2020) (revising 15 C.F.R. § 732, 734, 738, 742, 744, 758, and 774), <https://www.federalregister.gov/documents/2020/04/28/2020-07241/expansion-of-export-reexport-and-transfer-in-country-controls-for-military-end-use-or-military-end>;

Expansion of Export, Reexport, and Transfer (In-Country) Controls for Military End Use or Military End Users in the People's Republic of China, Russia, or Venezuela; Correction, 85 Fed. Reg. 34,306 (June 3, 2020) (revising 15 C.F.R. § 774), <https://www.federalregister.gov/documents/2020/06/03/2020-09717/expansion-of-export-reexport-and-transfer-in-country-controls-for-military-end-use-or-military-end>.

⁴³ "Debarred Parties," U.S. Department of State Directorate of Defense Trade Controls, accessed July 13, 2020, https://www.pmddtc.state.gov/ddtc_public?id=ddtc_kb_article_page&sys_id=c22d1833d6b8d300d0a370131f9619f0.

⁴⁴ "Specially Designated Nationals And Blocked Persons List (SDN) Human Readable Lists," U.S. Department of the Treasury, July 10, 2020, <https://www.treasury.gov/resource-center/sanctions/sdn-list/pages/default.aspx>.

⁴⁵ 15 C.F.R. Supplement No. 4 to § 744, <https://www.bis.doc.gov/index.php/documents/regulations-docs/2326-supplement-no-4-to-part-744-entity-list-4/file>.

⁴⁶ These technologies include items on the Commerce Control List plus items not on the list. The latter are called "EAR99" items.

⁴⁷ Exceptions include "[g]eneral scientific, mathematical, or engineering principles commonly taught in schools, colleges, and universities," "basic marketing information on function or purpose or general system descriptions of controlled items," or "[p]ublic domain information which is published and is accessible or available to the public, unrestricted: publications & conferences, patents, fundamental research." 22 CFR § 120.10.

⁴⁸ Addition of Certain Entities; and Modification of Entry on the Entity List, 83 Fed. Reg. 37,423 (August 1, 2018) (revising 15 C.F.R. § 744), <https://www.federalregister.gov/documents/2018/08/01/2018-16474/addition-of-certain-entities-and-modification-of-entry-on-the-entity-list>.

⁴⁹ Addition of Certain Entities to the Entity List, 84 Fed. Reg. 54,002 (October 9, 2019) (revising 15 C.F.R. § 744), <https://www.federalregister.gov/documents/2019/10/09/2019-22210/addition-of-certain-entities-to-the-entity-list>.

⁵⁰ Addition of an Entity to the Entity List, 83 Fed. Reg. 54,519 (October 30, 2018) (revising 15 C.F.R. § 744), <https://www.federalregister.gov/documents/2018/10/30/2018-23693/addition-of-an-entity-to-the-entity-list>. China's president Xi Jinping had designated Chinese memory chip makers Fujian Jinhua, Hefei Changxin, and Tsinghua Unigroup's

Yangtze River Memory as China's three future champions of memory chipmaking. David McLaughlin and Chris Strohm, "China State-Owned Company Charged With Micron Secrets Theft," *Bloomberg*, November 1, 2018, <https://www.bloomberg.com/news/articles/2018-11-01/u-s-says-china-state-owned-co-stole-micron-trade-secrets>.

⁵¹ "The Chipmaker Caught in U.S. Assault on China's Tech Ambitions," *Bloomberg*, November 28, 2018, <https://www.bloomberg.com/news/articles/2018-11-25/the-chipmaker-caught-in-u-s-assault-on-china-s-tech-ambitions>.

⁵² Japan's export control agency, the Ministry of Economy, Trade and Industry, gave no instructions to Japanese SME firms. Additionally, these firms suggested that the *de minimis* rule would not apply Japanese SME exports to China, as such exports do not include sufficient U.S.-origin content. Makiko Yamazaki. "Exclusive: Top Japanese chip gear firm to honor U.S. blacklist of Chinese firms - executive," *Reuters*, June 11, 2019, <https://www.reuters.com/article/us-usa-trade-china-semiconductors-exclus/exclusive-top-japanese-chip-gear-firm-to-honor-us-blacklist-of-chinese-firms-executive-idUSKCN1TC0H6>.

⁵³ Kathrin Hille, "Trade war forces Chinese chipmaker Fujian Jinhua to halt output," *Financial Times*, January 28, 2019, <https://www.ft.com/content/87b5580c-22bf-11e9-8ce6-5db4543da632>.

⁵⁴ Bureau of Industry and Security, "Huawei Temporary General License Extension Frequently Asked Questions (FAQs)," May 18, 2020, <https://www.bis.doc.gov/index.php/documents/pdfs/2446-huawei-entity-list-temporary-general-license-extension-faqs/file>.

⁵⁵ U.S. Department of Commerce, "U.S. Department of Commerce Extends Huawei Temporary General License," November 18, 2019, <https://www.commerce.gov/news/press-releases/2019/11/us-department-commerce-extends-huawei-temporary-general-license>.

⁵⁶ Addition of Huawei Non-U.S. Affiliates to the Entity List, the Removal of Temporary General License, and Amendments to General Prohibition Three (Foreign-Produced Direct Product Rule), 85 Fed. Reg. 51,596 (August 17, 2020) (revising 15 C.F.R. § 736, 744, and 762), <https://www.federalregister.gov/documents/2020/08/20/2020-18213/addition-of-huawei-non-us-affiliates-to-the-entity-list-the-removal-of-temporary-general-license-and>.

⁵⁷ Intel can use its foreign fabs in Ireland or Israel to supply Huawei. Cecilia Kang and Paul Mozur, "U.S. Tech Companies Sidestep a Trump Ban, to Keep Selling to Huawei," *The New York Times*, June 25, 2019, <https://www.nytimes.com/2019/06/25/technology/huawei-trump-ban-technology.html>; Ian King and Jenny Leonard, "U.S. Companies Find Legal Ways Around Trump's Huawei Blacklist," *Bloomberg*, June 25, 2019, <https://www.bloomberg.com/news/articles/2019-06-26/u-s-companies-are-finding-a-legal-way-around-huawei-blacklist>. The U.K. firm Arm, which licenses IP cores for Huawei's chip designs, initially stopped working with Huawei based on its determination that its designs include "U.S.-origin technology" (likely meaning technical data). Dave Lee, "Huawei: ARM memo tells staff to stop working with China's tech giant," *BBC News*, May 22, 2019. <https://www.bbc.com/news/technology-48363772>. Arm later resumed sales to Huawei and stated that its designs were U.K.-origin. "ARM and

Qualcomm Will Continue to Supply Huawei Despite US Ban," *Synced*, September 26, 2019, <https://syncedreview.com/2019/09/26/arm-and-qualcomm-will-continue-to-supply-huawei-despite-us-ban/>.

⁵⁸ Yoko Kubota and Dan Strumpf, "American Threat to Huawei's Chip Maker Shows Chinese Tech Isn't Self-Sufficient," *The Wall Street Journal*, June 2, 2019, <https://www.wsj.com/articles/huaweis-main-chip-maker-faces-long-term-risks-from-u-s-ban-11559467846>.

⁵⁹ Cheng Ting-Fang and Lauly Li, "Huawei loses access to vital chip design updates from Synopsys," *Nikkei Asian Review*, May 31, 2019, <https://asia.nikkei.com/Spotlight/Huawei-crackdown/Huawei-loses-access-to-vital-chip-design-updates-from-Synopsys>.

⁶⁰ 85 Fed. Reg. 51,596. A previous, superceded version of expanded re-export rules prevented Huawei from obtaining chips manufactured by non-U.S. foundries using U.S. SME and based on Huawei's chip designs. U.S. Department of Commerce, "Commerce Addresses Huawei's Efforts to Undermine Entity List, Restricts Products Designed and Produced with U.S. Technologies," May 15, 2020, <https://www.commerce.gov/news/press-releases/2020/05/commerce-addresses-huaweis-efforts-at-TSMC-undermine-entity-list-restricts>. These rules would not have prevented TSMC from shipping chips to Huawei that were not designed by Huawei, as TSMC claims its exports to Huawei do not fall under the original entity listing. "Taiwan's computing titans are caught up in the US-China tech war," *Economist*, June 8, 2019, <https://www.economist.com/business/2019/06/06/taiwans-computing-titans-are-caught-up-in-the-us-china-tech-war>. TSMC argued that U.S.-origin IP and materials counts toward the de minimis rule for its chip production, but U.S.-origin SME does not. Kensaku Ihara, Cheng Ting-Fang and Lauly Li, "TSMC says its chips for Huawei do not fall under US hammer," *Nikkei Asian Review*, May 23, 2019, <https://asia.nikkei.com/Spotlight/Huawei-crackdown/TSMC-says-its-chips-for-Huawei-do-not-fall-under-US-hammer>. However, the de minimis rule states that U.S.-origin IP's contribution to foreign re-exports of commodities should not count toward the de minimis rule.

⁶¹ Iris Deng, "Huawei will use its own phone chips amid report UK design firm ARM has cut business ties, says analyst," *South China Morning Post*, May 23, 2019, <https://www.scmp.com/tech/big-tech/article/3011437/huawei-will-use-its-own-phone-chips-amid-report-uk-design-firm-arm>.

⁶² From 2018 to 2019, the percentage of Huawei phones with Qualcomm chips dropped from 24 percent to 8.6 percent, with MediaTek chips rising from 7.3 percent to 16.7 percent. Jusy Hong, "DIY chips: Samsung and Huawei increasingly turn to in-house application processors for their smartphone lines," *Informa Tech*, January 6, 2020, <https://web.archive.org/web/20200417120324/https://technology.informa.com/620106/diy-chips-samsung-and-huawei-increasingly-turn-to-in-house-application-processors-for-their-smartphone-lines>.

⁶³ Kate O'Keeffe and Brian Spegele, "How a Big U.S. Chip Maker Gave China the 'Keys to the Kingdom'," *The Wall Street Journal*, June 27, 2019, <https://www.wsj.com/articles/u-s-tried-to-stop-china-acquiring-world-class-chips-china-got-them-anyway-11561646798>.

⁶⁴ Kate O'Keeffe and Asa Fitch, "U.S. Targets China's Supercomputing Push With New Export Restrictions," *The Wall Street Journal*, June 21, 2019,

<https://www.wsj.com/articles/u-s-targets-chinas-supercomputing-push-with-new-export-restrictions-11561129547>; Addition of Entities to the Entity List and Revision of an Entry on the Entity List, 84 Fed. Reg. 29,371 (June 24, 2019) (revising 15 C.F.R. § 744), <https://www.federalregister.gov/documents/2019/06/24/2019-13245/addition-of-entities-to-the-entity-list-and-revision-of-an-entry-on-the-entity-list>.

⁶⁵ O’Keeffe, “Keys to the Kingdom.”

⁶⁶ Stewart Randall, “Did AMD really give away ‘keys to the kingdom’?,” *TechNode*, July 10, 2019, <https://technode.com/2019/07/10/did-amd-really-give-away-keys-to-the-kingdom/>.

⁶⁷ Chinese chip designer Zhaoxin has developed x86 CPUs in a joint venture with Taiwanese chip designer VIA Technologies, which has a minor foothold in the x86 market. Paul Alcorn, “Zhaoxin KaiXian x86 CPU Tested: The Rise of China’s Chips,” *Tom’s Hardware*, April 10, 2020, <https://www.tomshardware.com/features/zhaoxin-kx-u6780a-x86-cpu-tested>.

⁶⁸ Addition of Certain Persons to the Entity List; and Removal of Person From the Entity List Based on a Removal Request, 80 Fed. Reg. 8524 (February 18, 2015) (revising 15 C.F.R. § 744), <https://www.federalregister.gov/documents/2015/02/18/2015-03321/addition-of-certain-persons-to-the-entity-list-and-removal-of-person-from-the-entity-list-based-on-a>.

⁶⁹ Brian Barrett, “China’s New Supercomputer Puts the US Even Further Behind.” *Wired*, June 21, 2016, <https://www.wired.com/2016/06/fastest-supercomputer-sunway-taihulight/>. It is unclear whether the Sunway chips were fabricated at Taiwanese fab TSMC or at a local Chinese fab.

⁷⁰ 85 Fed. Reg. 23,459.

⁷¹ Judith Alison Lee, Chris Timura, R.L. Pratt, Samantha Sewall, Laura Cole and Josh Shuo Zhang, “U.S. Moves to Tighten Export Controls on China and other Jurisdictions with Policies of Civil-Military Fusion,” Gibson Dunn, May 4, 2020, <https://www.gibsondunn.com/us-moves-to-tighten-export-controls-on-china-and-other-jurisdictions-with-policies-of-civil-military-fusion/>.

⁷² For example, they cover all items listed under ECCNs 3A991, 3A992, 3A999, 3B991, 3B992, 3C992, and 3D991, among others. ECCN 3A991 covers CPUs and AI ASICs. The plain language of ECCN 3A991 arguably cover GPUs, but GPU-maker AMD classifies its GPUs as “EAR99,” which applies to dual-use items not listed on the Commerce Control List. AMD, “AMD Regulatory Trade Compliance.” FPGAs are controlled under 3A001.a.7.

⁷³ John P. Barker, Soo-Mi Rhee, Nicholas L. Townsend, Tom McSorley, Emma Dinan, Junghyun Baek, Trevor G. Schmitt, “The US Further Restricts Exports to China, Russia and Venezuela—Including Many Commercial Electronics Items and Software,” Arnold and Porter, April 30, 2020, <https://www.arnoldporter.com/en/perspectives/publications/2020/04/us-restricts-exports-to-china-russia-venezuela>.

⁷⁴ Dan Strumpf, “U.S. Sets Export Controls on China’s Top Chip Maker,” *The Wall Street Journal*, September 28, 2020, <https://www.wsj.com/articles/u-s-sets-export-controls-on-chinas-top-chip-maker-11601118353>.

⁷⁵ 15 C.F.R. Supplement 7 to § 748.

<https://www.bis.doc.gov/index.php/documents/validated-end-user/457-supplement-no-7-to-part-748-veu-list/file>.

⁷⁶ Amendment to the Export Administration Regulations: Removal of Semiconductor Manufacturing International Corporation From the List of Validated End-Users in the People's Republic of China, 81 Fed. Reg. 87,426 (December 5, 2015) (revising 15 C.F.R. § 748), <https://www.bis.doc.gov/index.php/documents/regulations-docs/federal-register-notices/federal-register-2016/1611-81-fr-87426/file>.

⁷⁷ Data on China's imports from all countries tell a similar tale. While China's imports as a whole are declining, China's imports of chips and SME have been increasing. "China Stockpiles Foreign Tech as 'Silicon Curtain' Descends," *Bloomberg*, December 3, 2019, <https://www.bloomberg.com/news/articles/2019-12-03/china-stockpiles-foreign-tech-as-silicon-curtain-descends>.

⁷⁸ "Economics and Trade Bulletin," (Washington, DC: U.S.-China Economic and Security Review Commission, January 11, 2019), 9, <https://www.uscc.gov/sites/default/files/Research/January%202019%20Trade%20%20Bulletin.pdf>.

⁷⁹ John VerWey, *What's Causing U.S. Semiconductor Equipment Production and Exports to Grow?* (Washington, DC: U.S. International Trade Commission, January 2019), 2, https://www.usitc.gov/publications/332/executive_briefings/ebot_john_verwey_semi_manufacturing_equipment_pdf.pdf.

⁸⁰ As part of the U.S. government's Export Control Reform Initiative, military-grade semiconductor technologies were transferred from the U.S. Munitions List to the Commerce Control List in 2014. Edward J. Krauland, Meredith Rathbone, Andrew D. Irwin, Jack R. Hayes, Alexandra E.P. Baj and Henry N. Smith, "Export control reform – military electronics and spacecraft," *Lexology*, July 16, 2014, <https://www.lexology.com/library/detail.aspx?g=e2053f48-738f-4e7c-8bdd-1b3dca8b913b>. This change may have reduced the scope of controls, resulting in increased exports. Andrea Stricker with David Albright, "U.S. Export Control Reform: Impacts and Implications for Controlling the Export of Proliferation-Sensitive Goods and Technologies, A Policy Document for the New President and Congress," (Washington, DC: Institute for Science and International Security, May 17, 2017), <https://isis-online.org/isis-reports/detail/u.s.-export-control-reform-impacts-and-implications/>.

⁸¹ Susan N. Houseman and Michael Mandel, *Measuring Globalization: Better Trade Statistics for Better Policy* (Kalamazoo, MI: W.E. Upjohn Institute, 2015), 81-118; Kimberly Bayard, David Byrne and Dominic Smith, "Chapter 4: The Scope of U.S. 'Factoryless' Manufacturing," https://www.jstor.org/stable/j.ctvh4zfcn.23?seq=1#metadata_info_tab_contents.

⁸² The chips and OSD data includes exports associated with Harmonized Tariff Schedule categories 8541 and 8542.

⁸³ The SME data includes exports associated with Harmonized Tariff Schedule categories 8480.71.4000, 8486, 8543.70.2000, 8543.90.1100, 9030.82, and 9031.41. Fab equipment includes all categories of SME except assembly, testing, and packaging equipment.

⁸⁴ The materials and inputs data includes exports associated with Harmonized Tariff Schedule categories 2804.61.0000, 2825.60.0000, 2849.20.1000, 3701.30.0000, 3701.99.6030, 3701.99.7000, 3707.90.0000, 3818.00.0000, 8112.92.0600, and 8112.92.9000. Silicon, silicon carbide, gallium arsenide, and germanium are commonly used to produce wafers. Silicon is by far the most common.

⁸⁵ BIS makes an RWA decision when, for example, the license is not required or if more information is needed.

⁸⁶ "Licensing Analysis," Bureau of Industry and Security.
<https://www.bis.doc.gov/index.php/statistical-reports/licensing-analysis>. "Country Analysis," Asia Analysis, Bureau of Industry and Security,
<https://www.bis.doc.gov/index.php/statistical-reports/country-analysis/asia>.

⁸⁷ O'Keeffe et al., "New Export Restrictions."

⁸⁸ Deemed export applications for Chinese nationals were more popular for semiconductor technical data than for any other type of technical data. Specifically, the ECCN 3E001 was the most commonly approved deemed export license application for Chinese nationals. Bureau of Industry and Security, "Deemed Export Licenses," March 5, 2019,
<https://www.bis.doc.gov/index.php/documents/technology-evaluation/ote-data-portal/licensing-analysis/2410-2018-statistical-analysis-of-bis-licensing-pdf/file>.

⁸⁹ O'Keeffe et al., "New Export Restrictions."

⁹⁰ This dataset includes some irregularities. For example, the number of applicants does not match the application counts in BIS's published reports, suggesting that two datasets count applicants and applications differently. This dataset also includes dollar values, but this report does not present that data due to irregularities such as outlier data points.

⁹¹ United States General Accounting Office, *Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review* (Washington, DC: United States Congress, April 2002), 3,
<https://www.gao.gov/assets/240/234373.pdf>.

⁹² All seven applications were categorized under ECCN 3B001, which covers "Equipment for the manufacturing of semiconductor devices or materials."

⁹³ Up to 2015, the Wassenaar Arrangement and the U.S. Commerce Control List listed anisotropic dry etching equipment. In 2015, BIS found that China was producing this equipment. Foreign Availability Determination: Anisotropic Plasma Dry Etching Equipment, 80 Fed. Reg. 6948 (February 9, 2015),
<https://www.federalregister.gov/documents/2015/02/09/2015-02681/foreign-availability-determination-anisotropic-plasma-dry-etching-equipment>. After this finding, the Wassenaar Arrangement and, effective September 20, 2016, the U.S. Commerce Control List were amended to remove this equipment. Wassenaar Arrangement 2015 Plenary Agreements Implementation, Removal of Foreign National Review Requirements, and Information Security Updates, 81 Fed. Reg. 64,655 (September 20, 2016) (revising 15 CFR § 730, 734, 738, 740, 742, 743, 748, 770, 772, and 774.
<https://www.federalregister.gov/documents/2016/09/20/2016-21544/wassenaar-arrangement-2015-plenary-agreements-implementation-removal-of-foreign-national-review>.

⁹⁴ Cheng Ting-Fang, "Chinese chipmaker takes on TSMC and Intel with cutting-edge tool," *Nikkei Asian Review*, May 15, 2018, <https://asia.nikkei.com/Business/Companies/Chinese-chip-maker-invests-in-next-gen-tool-to-close-gaps-with-Intel-TSMC-Samsung>.

⁹⁵ David Manners, "China buys first EUV machine," September 29, 2018, *Electronics Weekly*, <https://www.electronicsworld.com/news/business/china-buys-first-euv-machine-2018-09/>.

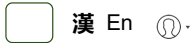
⁹⁶ Alexandra Alper, Toby Sterling, and Stephen Nellis, "Trump administration pressed Dutch hard to cancel China chip-equipment sale," *Reuters*, January 6, 2020, <https://www.reuters.com/article/us-asml-holding-usa-china-insight-idUSKBN1Z50HN>; Cheng Ting-Fang and Laury Li, "Exclusive: ASML chip tool delivery to China delayed amid US ire," *Nikkei Asian Review*, November 6, 2019, <https://asia.nikkei.com/Economy/Trade-war/Exclusive-ASML-chip-tool-delivery-to-China-delayed-amid-US-ire>. The Chinese government responded that this export ban could damage bilateral relations between China and the Netherlands. Toby Sterling and Anthony Deutsch, "Chinese ambassador warns Dutch government against restricting ASML supplies," *Reuters*, January 15, 2020, <https://www.reuters.com/article/us-netherlands-asml-china-idUSKBN1ZE1Z8>.

⁹⁷ 85 Fed. Reg. 23,459.

⁹⁸ 85 Fed. Reg. 52,934.

⁹⁹ Revitalizing Multilateral Export Control Diplomacy for Critical Technologies Act, H.R. 8329, 116th Cong. (2020).

Exhibit C



Home / Business

Taiwan's UMC freezes ties with Chinese firm in response to US sanctions

UMC stops R&D activity with Chinese firm after it was banned from buying U.S. products on national security grounds

2963 Like 19 Share Tweet 分享

By Scott Morgan, Taiwan News, Staff Writer

2018/11/01 17:58



(Image from UMC's website)

TAIPEI (Taiwan News) – Taiwan's second-largest contract chipmaker United Microelectronics Corp. (UMC, 聯華電子) has frozen its dealings with Chinese state-owned semiconductor firm Fujian Jinhua Integrated Circuit Co., after the company was sanctioned by the U.S. government on national security grounds.

UMC said in a statement on Oct. 31 that they will halt all research and development activities with the Chinese state-owned company "until we are cleared to resume by the appropriate authorities."

The U.S. Department of Commerce added Fujian Jinhua Integrated Circuit Co. to a list of entities that cannot buy intermediate goods, software, or other technology from U.S. firms, citing national security grounds.

Fujian Jinhua Integrated Circuit Co. "poses a significant risk of becoming involved in activities that are contrary to the national security interests of the United States," the U.S. Department of Commerce said in a statement.

Department of Commerce Secretary Wilbur Ross said the move "will limit its ability to threaten the supply chain for essential components in our military systems," in a separate statement.

Fujian Jinhua Integrated Circuit Co. was founded as part of China's 13th five-year economic plan and is directly linked to the government's Made in China 2025 strategic plan which hopes to boost domestic manufacturing in high-technology industries.

UMC and Fujian Jinhua Integrated Circuit Co. are jointly working on production of DRAM technology, with the goal of jointly developing and manufacturing new forms of electronic hardware, according to CNA.

UMC previously said their relationship with Fujian Jinhua Integrated Circuit Co. would remain unchanged by the Department of Commerce ruling.

Taiwan tech Sanctions US-China trade war UMC




Like 19 Share Tweet 分享

RELATED ARTICLES



US bans cotton imports from China producer XPCC citing Xinjiang 'slave labor'

2020/12/03 10:05

	HK chief executive having to keep piles cash at home	2020/11/29 14:08
	Taiwan's Foxconn to move some Apple production from China to Vietnam	2020/11/27 12:31
	US imposes sanctions on four Chinese officials over Hong Kong crackdown	2020/11/10 17:00
	Taiwan's UMC admits to stealing trade secrets for Chinese company	2020/10/29 12:29



Updated : 2020-12-10 16:52 GMT+08:00

MOST POPULAR








	47 workers test positive for Covid in Uganda despite Chinese vaccine
	Taiwan police officer attacked by flesh-eating Asian giant hornet
	Chinese netizens cry foul over Taiwan flag on South Korea's 'Running Man'
	Taiwanese banned from all UNESCO events
	Taiwan's minister of economic affairs responds to Biden's refusal to sign any trade agreement
	Russian woman looking for son after Taiwanese family takes him on 'trip'
	Taiwan's heavy fine for migrant worker who broke quarantine sparks controversy
	Temperatures across Taiwan forecast to plummet Sunday
	Taiwan rated only country in Asia with open civic space in 2020
	South Korea promises harsh punishment for driver who killed Taiwanese student



Exhibit D



[Home](#) / [Business](#) / [Companies](#) 

Micron bets on Xi'an plant for accolades

By Ma Si | China Daily | Updated: 2020-04-16 10:07



Manish Bhatia, executive vice-president of global operations at Micron. [Photo provided to China Daily]

Micron Technology Inc's manufacturing plant in Xi'an, Shaanxi province, saw record production despite the COVID-19 pandemic, further reiterating the US chipmaker's commitment to China, a top company official said.

The chipmaker took a series of measures to ensure the health and safety of its employees in the country at a very early stage of the outbreak, said Manish Bhatia, executive vice-president of global operations at Micron. The Xi'an chip packaging and testing plant has been operating at full capacity since January despite the epidemic.

"Our Xi'an plant was not shut for even a single day and none of our team members in China

were infected by the virus," Bhatia said, adding that the company has mandated temperature scanning at its factories every day, and let employees wear masks from a very early stage.

According to him, currently, the Xi'an plant has adequate supplies of raw materials and components, but as the novel coronavirus makes inroads into more countries, there is a concern about possible short supply.

The senior executive said that the company is working very closely with its material suppliers to expedite shipments, increase inventory levels, and accelerate equipment arrivals so that it can continue to ramp up production.

Micron is seeing a growing demand for the products it makes in Xi'an, mainly DRAM chips which are used in cloud computing, servers and personal computers.

"We have seen an increase in demand from scientists working on super computers to help find a cure for the virus, and people using big data analytics to trace the spread of the outbreak," Bhatia said, adding that with more consumers staying at home for work and study, the demand for Micron's products is also rising.

As one of the world's largest makers of memory chips, Micron has been in China for more than a decade. Currently, it has about 3,700 employees in the country. In addition to the Xi'an plant, it boasts an engineering center in Shanghai. To offer better localized products and services, Micron also has sales, marketing and customer labs in Beijing, Shanghai and Shenzhen, Guangdong province.

"China is a very important market for us," Bhatia said, adding that the company is not changing its plans for the nation; its Xi'an facility will continue running at full throttle, and Micron will continue introducing new products.

Market research company Gartner Inc forecast that global semiconductor revenue is likely to decline by 0.9 percent on a yearly basis this year due to the coronavirus impact on semiconductor supply and demand.

When it comes specifically to DRAM chips, Gartner predicted that strong demand from cloud

service providers in the first half of this year will push pricing and revenue higher in the server DRAM market. However, this growth will be more than offset by weak demand and falling prices in the smartphone market, Richard Gordon, research practice vice-president at Gartner, said in the report.

Bhatia expressed concern about the pandemic's impact on the smartphone and automobile industries. Smartphone makers are major buyers of chips and if their business is not good, it will affect the semiconductor industry.

To help the world combat the pandemic, Micron recently announced a \$35 million donation plan to assist those disproportionately affected by COVID-19. About 81.7 percent of Micron employees in China are getting 2,500 yuan (\$354) from the company as assistance payment.

Related Stories

[Wuhan restarts: World-first flash memory chip released](#)

[Closer global cooperation, not trade restrictions, essential](#)

[Top 10 fastest-growing companies listed on US stock market](#)

[Top six fastest-growing Chinese companies](#)

[Antitrust officials: All firms treated equally](#)



Copyright 1995 - 2020 . All rights reserved. The content (including but not limited to text, photo, multimedia information, etc) published in this site belongs to China Daily Information Co (CDIC). Without written authorization from CDIC, such content shall not be republished or used in any form.

Exhibit E

INTERVIEW

Micron says emerging Chinese rivals pose no threat -- for now

US chipmaker taps AI and smart tech to keep plants running amid pandemic



U.S. memory chip maker Micron Technology is confident it can fend off Chinese rivals for the time being. © Reuters

CHENG TING-FANG and LAULY LI, Nikkei staff writers

October 7, 2020 13:00 JST

TAIPEI -- Micron Technology is confident that its Chinese rivals will not be able to challenge the largest U.S. memory chipmaker anytime soon, despite Beijing's efforts to cut reliance on foreign chip suppliers, a senior executive at the American company told Nikkei Asia in an exclusive interview.

Manish Bhatia, Micron's executive vice president, said that even with "deep pockets" it will take time for Chinese newcomers to make a significant impact on the global memory chip market, but stressed that his company takes all competition seriously and is paying close attention to the progress of emerging Chinese competitors.

"Micron has more than 40 years of experience building fabs [chip facilities], building technology roadmaps, getting to high yield, low density, high quality, high reliability, high performance, low cost," Bhatia told Nikkei Asia on Monday. "It's not easy to replicate overnight."

Chinese newcomers, moreover, "have to keep up with the rest of the industry, and it's not a standstill target but a moving target. So even if they get something working, they've got to catch up. That's the challenge to enter a market, even when you have deep pockets."

Bhatia's remarks come as the U.S.-China tech war is heating up: While Beijing is throwing its support behind homegrown chipmakers like Yangtze Memory Technologies, the country's first 3D NAND flash chipmaker, to **replace foreign suppliers**, Micron has been forced to suspend ties with its largest Chinese customer, Huawei Technologies. Huawei, the world's biggest telecom equipment provider, is the target of an ongoing crackdown by Washington, which views the company as a security threat.



Micron Technology Executive Vice President Manish Bhatia says his company remains committed to the Chinese market despite Washington's crackdown on Huawei.

Micron recently told investors that it had applied for a license to ship to Huawei after Washington's latest tightening of export restrictions on the Chinese company. Samsung Electronics, SK Hynix, Sony and Kioxia, formally known as Toshiba Memory, as well as Taiwanese mobile chipmaker Mediatek all said they have applied for licenses to continue some business with Huawei. So far, only Intel and AMD, the world's two top makers of PC and server microprocessors, have publicly confirmed they have been granted licenses by the U.S. government, but neither disclosed which products those licenses cover.

Micron had not heard whether its license application had been approved or rejected as of Monday, but Bhatia said the company remains committed to serving its China-based customers, which account for around 20% of its revenue. Micron also has manufacturing and R&D capabilities in the country and has "always wanted to support the Chinese ecosystem," he added.

"We are continuing to be engaged with them not just today, but on roadmaps for tomorrow and helping them to meet their product requirements for the future," the executive said.

Micron is the world's third-largest maker of dynamic random access memory, or DRAM, after Samsung Electronics and SK Hynix of South Korea, and it is the No.4 player in NAND flash memory, trailing Samsung, Japan's Kioxia, and Western Digital of the U.S. Both DRAM and NAND flash are critical memory components widely used in almost all electronics devices.

Though Washington-Beijing tensions and the coronavirus pandemic have created uncertainty for the company, Micron's financial performance has remained resilient and it has not had to completely halt production for even one day since the coronavirus outbreak. The only place where production was affected was Malaysia, where Micron lowered the production level in its chip packaging and testing facility due to a government order. Micron reported a 24% growth in revenue on the year and an 80% increase in net profit for the three months ending Sept. 3. However, it expects to feel the impact of the tighter U.S. restrictions on Huawei in the current and next quarters.

Micron attributed its ability to maintain production levels to years of introducing artificial intelligence and machine learning into its manufacturing sites, as well as to its deployment of safety measures in its Asian and U.S. facilities as soon as Beijing ordered the lockdown of the Chinese city of Wuhan following the outbreak of the coronavirus in late January. Micron's most important DRAM chip production bases are in Taiwan and Japan, while Singapore is its most significant NAND production base.

"If China was scared enough that they felt they needed to lock Wuhan down, that was enough for me to trigger and say we need to be focused on this, not just in China, but all of Asia," Bhatia told Nikkei Asia. "We implemented all these measures across all of our sites in Asia and even in the U.S., eventually. I don't think anybody predicted it would become a bad and a full global pandemic like it has become."

In late January, Micron began monitoring the temperatures of everyone entering its facilities, split workers into "red" and "blue" teams to minimize contact, and reduced the number of visitors to the sites, Bhatia said. The memory chipmaker even split operations at its fab facilities around the world in two to ensure production would not be disrupted if someone contracted the virus. "Fortunately, we never had anything happen like that."

The pandemic also prompted Micron to accelerate its adoption of new technologies -- from virtual and augmented reality headsets to AI, machine learning and big data analysis -- to keep its global facilities up and running remotely when engineers and technicians from equipment suppliers like Applied Materials and ASML could not travel across borders.

The implementation of AI has helped Micron achieve "a 30 % reduction in unplanned downtime of our equipment, a 40% reduction in low product yield events, and a 20% improvement in our yield learning curve," Bhatia said.

Micron foresees uncertainty in the next two quarters, both for itself and its peers, due to the latest U.S. ban on Huawei, which forced all suppliers to suspend unlicensed shipments to the Chinese tech giant. But Bhatia said Micron expects demand for memory chips for data centers to remain healthy thanks to the rise of remote working, while the smartphone and automobile industries are also showing improving demand driven by the introduction of 5G networks.

"We're very well-positioned for a 5G recovery with so many mobile phone customers. We're diversified through almost every mobile phone customer except Huawei. So [we are] really doing a good job of being positioned to succeed and benefit as 5G ramps up," Bhatia said.

Micron predicted 5G smartphone shipments will more than double to 500 million units in 2021, from around 200 million units this year. Bhatia described this as just the beginning of the 5G revolution, which will drive further innovation and demand for memory chips.

A challenge that Micron is still grappling with is how to offset the impact of the Huawei ban, Bhatia said.

"The risk is really around timing. ... This last calendar fourth quarter, we have to deal with not being able to ship to Huawei. We have to figure out how to realign our supply ... We have to figure out how long this works out," he said, adding that it takes time to achieve a balance of supply and demand. "But as we go through the calendar year 2021, we expect to see an economic recovery."

Avril Wu, an analyst with Trendforce, said the biggest uncertainty is whether the global pandemic can be contained. If it is not, the outbreak will eventually impact electronics demand as well as the memory chip market.

"The DRAM memory market will still be stable and we foresee recovery from next year, while NAND flash memories will suffer more as there are more players in the world making such memory chips," Wu said. "We foresee China's Yangtze Memory, the country's top NAND flash memory maker, could become a real challenger that could start to have an influence on market supply from 2021."

Exhibit F

2020-12-17

4YOU DIALY

(HTTPS://4YOU DAILY.COM/)

TECH NEWS FOR YOU DAILY

[🏠 \(https://4youdaily.com/\)](https://4youdaily.com/)
[INÍCIO \(HTTPS://4YOU DAILY.COM\)](https://4youdaily.com/)
[HARDWARE NEWS \(HTTPS://4YOU DAILY.COM/CATEGORY/HARDWARE-NEWS/\)](https://4youdaily.com/category/hardware-news/)

[Home \(https://4youdaily.com/\)](https://4youdaily.com/) / [RAM modules, memory cards, flash drives, card readers \(https://4youdaily.com/category/ram-modules-memory-cards-flash-drives-card-readers/\)](https://4youdaily.com/category/ram-modules-memory-cards-flash-drives-card-readers/) /

[Experience is more important than money: Micron does not believe in the imminent success of Chinese memory manufacturers and is not afraid of competition with them \(https://4youdaily.com/ram-modules-memory-cards-flash-drives-card-readers/experience-is-more-important-than-money-micron-does-not-believe-in-the-imminent-success-of-chinese-memory-manufacturers-and-is-not-afraid-of-competition-with-them/\)](https://4youdaily.com/ram-modules-memory-cards-flash-drives-card-readers/experience-is-more-important-than-money-micron-does-not-believe-in-the-imminent-success-of-chinese-memory-manufacturers-and-is-not-afraid-of-competition-with-them/)
[RAM modules, memory cards, flash drives, card readers \(https://4youdaily.com/category/ram-modules-memory-cards-flash-drives-card-readers/\)](https://4youdaily.com/category/ram-modules-memory-cards-flash-drives-card-readers/)
[Technology and IT market. news \(https://4youdaily.com/category/technology-and-it-market-news/\)](https://4youdaily.com/category/technology-and-it-market-news/)

Search ...

Search

Experience is more important than money: Micron does not believe in the imminent success of Chinese memory manufacturers and is not afraid of competition with them

2 min read

 2 months ago
 admin (<https://4youdaily.com/author/admin/>)


The South Korean company SK Hynix, as it became known the day before, considers the investment in Kioxia as a kind of protection against the future strengthening of the positions of Chinese competitors in the world market. Micron Technology representatives do not share such concerns yet, claiming that not everything in this type of business is solved by money.

Image Source: Reuters

In an interview with the Nikkei Asian Review, Micron Technology Executive Vice President Manish Bhatia said that even "deep pockets" will prevent Chinese memory manufacturers from quickly gaining a worthy place in the global market, although the American company sees all competitors as equals. Micron has over forty years of experience in developing and releasing memory, such expertise cannot be acquired overnight, Bhatia said.

For Chinese newbies, the situation is further complicated by the fact that they have to catch up with a constantly moving target. As soon as they move to a new stage, they will again have to make up for the gap with the leaders. For Micron itself, the Chinese market continues to be very important, the company receives up to 20% of total revenue in this country. Micron has manufacturing facilities and research centers here.

The company remains the third largest manufacturer of RAM chips in the world, and is content with the fourth position in the solid-state memory market. In the near future, Micron will have to compensate for the drop in revenue due to the possible exclusion of Huawei Technologies from the number of regular customers. The company applied for an export license in the United States, but as of this Monday, the status of this application has not been determined. Micron expects that if the pandemic

RECENT POSTS

Contributors 11-11: Memories Retold Introduce Road 96 – Procedural Generated Road Adventure (<https://4youdaily.com/games/contributors-11-11-memories-retold-introduce-road-96-procedural-generated-road-adventure/>)

Chinese spacecraft "Chang'e-5" with lunar samples completed the first of two maneuvers to escape the Moon (<https://4youdaily.com/space/chinese-spacecraft-change-5-with-lunar-samples-completed-the-first-of-two-maneuvers-to-escape-the-moon/>)

New trailer for co-op shooter Outriders gives tips on survival on Enoch (<https://4youdaily.com/games/new-trailer-for-co-op-shooter-outriders-gives-tips-on-survival-on-enoch/>)

Tesla's China Manufacturing Will Drive Electric Vehicle Sales in China by 40% in 2021 (<https://4youdaily.com/cars-motorcycles-vehicles/teslas-china-manufacturing-will-drive-electric-vehicle-sales-in-china-by-40-in-2021/>)

Roscosmos has published photographs of the creation of equipment for the Soyuz-5 launch vehicle (<https://4youdaily.com/space/roscomos-has-published-photographs-of-the-creation-of-equipment-for-the-soyuz-5-launch-vehicle/>)

RECENT COMMENTS

ARCHIVES

[December 2020 \(https://4youdaily.com/2020/12/\)](https://4youdaily.com/2020/12/)
[November 2020 \(https://4youdaily.com/2020/11/\)](https://4youdaily.com/2020/11/)
[October 2020 \(https://4youdaily.com/2020/10/\)](https://4youdaily.com/2020/10/)
[September 2020 \(https://4youdaily.com/2020/09/\)](https://4youdaily.com/2020/09/)
[August 2020 \(https://4youdaily.com/2020/08/\)](https://4youdaily.com/2020/08/)
[July 2020 \(https://4youdaily.com/2020/07/\)](https://4youdaily.com/2020/07/)

can be curbed within a reasonable time frame, the economy will begin to revive in 2021. The widespread use of automation and artificial intelligence, as well as compliance with additional sanitary safety measures at enterprises, helped to minimize the damage from the introduction of self-isolation.

Previous

Fewer numbers, more meaning: Monster Hunter has changed the naming convention of the series
(https://4youdaily.com/games/fewer-numbers-more-meaning-monster-hunter-has-changed-the-naming-convention-of-the-series/)

Next

Video: the player recreated the iconic scene from Return of the Jedi in Star Wars: Squadrons
(https://4youdaily.com/games/video-the-player-recreated-the-iconic-scene-from-return-of-the-jedi-in-star-wars-squadrons/)

MORE STORIES

2 min read

Games
(https://4youdaily.com/category/games/)

Technology and IT market. news
(https://4youdaily.com/category/technology-and-it-market-news/)

Contributors 11-11: Memories Retold Introduce Road 96 – Procedural Generated Road Adventure
(https://4youdaily.com/games/contributors-11-11-memories-retold-introduce-road-96-procedural-generated-road-adventure/)

Leave a Reply
Your email address will not be published. Required fields are marked *

Comment
5 days ago admin
(https://4youdaily.com/author/admin/)

2 min read

Space
(https://4youdaily.com/category/space/)

Technology and IT market. news
(https://4youdaily.com/category/technology-and-it-market-news/)

Chinese spacecraft “Chang’e-5” with lunar samples completed the first of two maneuvers to escape the Moon
(https://4youdaily.com/space/chinese-spacecraft-change-5-with-lunar-samples-completed-manuevers-to-escape-the-moon/)

5 days ago admin
(https://4youdaily.com/author/admin/)

2 min read

Games
(https://4youdaily.com/category/games/)

Technology and IT market. news
(https://4youdaily.com/category/technology-and-it-market-news/)

New trailer for co-op shooter Outriders gives tips on survival on Enoch
(https://4youdaily.com/games/new-trailer-for-co-op-shooter-outriders-gives-tips-on-survival-on-enoch/)

5 days ago admin
(https://4youdaily.com/author/admin/)

Name *

Email *

Website

☐ Save my name, email, and website in this browser for the next time I comment.

Post Comment

- CATEGORIES
- 0-9
(https://4youdaily.com/category/0-9/)

Acer
(https://4youdaily.com/category/acer/)

AMD
(https://4youdaily.com/category/amd/)

AMD processors
(https://4youdaily.com/category/amd-processors/)

Analytics
(https://4youdaily.com/category/analytics/)

Android Apps
(https://4youdaily.com/category/android-apps/)

Android software
(https://4youdaily.com/category/android-software/)

Android tablets, 9-10 " and more
(https://4youdaily.com/category/android-tablets-9-10-and-more/)

Antivirus, firewall, anti-spyware
(https://4youdaily.com/category/antivirus-firewall-anti-spyware/)

Apple
(https://4youdaily.com/category/apple/)

Apple computers and laptops
(https://4youdaily.com/category/apple-computers-and-laptops/)

Archivers
(https://4youdaily.com/category/archivers/)

Artificial Intelligence, Machine Learning, Neural Networks
(https://4youdaily.com/category/artificial-intelligence-machine-learning-neural-networks/)

ASRock
(https://4youdaily.com/category/asrock/)

ASUS
(https://4youdaily.com/category/asus/)

ASUS Republic of Gamers
(https://4youdaily.com/category/asus-republic-of-gamers/)

Audio / video peripherals, headphones, webcams
(https://4youdaily.com/category/audio-video-peripherals-headphones-webcams/)

Barebone systems, nettops, all-in-one PC, media centers
(https://4youdaily.com/category/barebone-systems-nettops-all-in-one-pc-media-centers/)

Benchmarking
(https://4youdaily.com/category/benchmarking/)

BQ
(https://4youdaily.com/category/bq/)

Browsers
(https://4youdaily.com/category/browsers/)

Canon
(https://4youdaily.com/category/canon/)

Cars, motorcycles, vehicles
(https://4youdaily.com/category/cars-motorcycles-vehicles/)

Cases, desktop computers
(https://4youdaily.com/category/cases-desktop-computers/)

Cloud gaming platforms
(https://4youdaily.com/category/cloud-gaming-platforms/)

Comments on recent events
(https://4youdaily.com/category/comments-on-recent-events/)

Comparative Reviews
(<https://4youdaily.com/category/comparative-reviews/>)

Comparative tests
(<https://4youdaily.com/category/comparative-tests/>)

Computer selection
(<https://4youdaily.com/category/computer-selection/>)

Contests of 3DNews and our partners
(<https://4youdaily.com/category/contests-of-3dnews-and-our-partners/>)

Cooling systems
(<https://4youdaily.com/category/cooling-systems/>)

CPU coolers (<https://4youdaily.com/category/cpu-coolers/>)

Data encryption and protection
(<https://4youdaily.com/category/data-encryption-and-protection/>)

Dell (<https://4youdaily.com/category/dell/>)

Development and manufacture of electronics
(<https://4youdaily.com/category/development-and-manufacture-of-electronics/>)

Developments. Facts. Forecasts
(<https://4youdaily.com/category/developments-facts-forecasts/>)

Digital cameras / camcorders, DSLRs, lenses, photo frames, flashes
(<https://4youdaily.com/category/digital-cameras-camcorders-dslrs-lenses-photo-frames-flashes/>)

Digital finance
(<https://4youdaily.com/category/digital-finance/>)

Drivers (<https://4youdaily.com/category/drivers/>)

Drives and media CD, DVD, Blu-ray
(<https://4youdaily.com/category/drives-and-media-cd-dvd-blu-ray/>)

Drones and copters
(<https://4youdaily.com/category/drones-and-copters/>)

Editorial announcements and announcements
(<https://4youdaily.com/category/editorial-announcements-and-announcements/>)

Environment
(<https://4youdaily.com/category/environment/>)

Events and events of the IT industry, exhibitions, forums (<https://4youdaily.com/category/events-and-events-of-the-it-industry-exhibitions-forums/>)

Exhibitions
(<https://4youdaily.com/category/exhibitions/>)

File managers (<https://4youdaily.com/category/file-managers/>)

Financial news and analytics
(<https://4youdaily.com/category/financial-news-and-analytics/>)

Game consoles
(<https://4youdaily.com/category/game-consoles/>)

Games (<https://4youdaily.com/category/games/>)

GamesBlender
(<https://4youdaily.com/category/gamesblender/>)

General information
(<https://4youdaily.com/category/general->

information/)

Gigabyte (<https://4youdaily.com/category/gigabyte/>)

Google (<https://4youdaily.com/category/google/>)

Graphic editor
(<https://4youdaily.com/category/graphic-editor/>)

Hard drives, storage systems, interfaces, NAS
(<https://4youdaily.com/category/hard-drives-storage-systems-interfaces-nas/>)

Hardware News
(<https://4youdaily.com/category/hardware-news/>)

Honor (<https://4youdaily.com/category/honor/>)

Housings
(<https://4youdaily.com/category/housings/>)

HP (<https://4youdaily.com/category/hp/>)

Huawei (<https://4youdaily.com/category/huawei/>)

IM clients (<https://4youdaily.com/category/im-clients/>)

Intel processors
(<https://4youdaily.com/category/intel-processors/>)

Interesting things from the world of high-tech
(<https://4youdaily.com/category/interesting-things-from-the-world-of-high-tech/>)

IOS Apps (<https://4youdaily.com/category/ios-apps/>)

IOS games (<https://4youdaily.com/category/ios-games/>)

IT fables (<https://4youdaily.com/category/it-fables/>)

IT market (<https://4youdaily.com/category/it-market/>)

Laptops (<https://4youdaily.com/category/laptops/>)

Laptops and netbooks
(<https://4youdaily.com/category/laptops-and-netbooks/>)

LCD monitors (<https://4youdaily.com/category/lcd-monitors/>)

Lenovo (<https://4youdaily.com/category/lenovo/>)

Mail clients (<https://4youdaily.com/category/mail-clients/>)

Manipulators, graphics input devices
(<https://4youdaily.com/category/manipulators-graphics-input-devices/>)

Mobile phones, smartphones, cellular communications, communicators, PDAs
(<https://4youdaily.com/category/mobile-phones-smartphones-cellular-communications-communicators-pdas/>)

Mobile software
(<https://4youdaily.com/category/mobile-software/>)

Monitors, projectors, TV tuners, televisions
(<https://4youdaily.com/category/monitors-projectors-tv-tuners-televisions/>)

Motherboards
(<https://4youdaily.com/category/motherboards/>)

Motorola
(<https://4youdaily.com/category/motorola/>)

MSI (<https://4youdaily.com/category/msi/>)

Nanotechnology
(<https://4youdaily.com/category/nanotechnology/>)

NAS (Network Attached Storage)
(<https://4youdaily.com/category/nas-network-attached-storage/>)

Network news
(<https://4youdaily.com/category/network-news/>)

Networks and communications
(<https://4youdaily.com/category/networks-and-communications/>)

Nikon (<https://4youdaily.com/category/nikon/>)

Nokia (<https://4youdaily.com/category/nokia/>)

NVIDIA (<https://4youdaily.com/category/nvidia/>)

Office Packages
(<https://4youdaily.com/category/office-packages/>)

On the cutting edge of science
(<https://4youdaily.com/category/on-the-cutting-edge-of-science/>)

OnePlus (<https://4youdaily.com/category/oneplus/>)

Operating Systems
(<https://4youdaily.com/category/operating-systems/>)

Oppo (<https://4youdaily.com/category/oppo/>)

Other (<https://4youdaily.com/category/other/>)

Overclocking and measuring system performance
(<https://4youdaily.com/category/overclocking-and-measuring-system-performance/>)

PC (<https://4youdaily.com/category/pc/>)

Photo, video, phrase of the day
(<https://4youdaily.com/category/photo-video-phrase-of-the-day/>)

Portable audio / video players, voice recorders, electronic books
(<https://4youdaily.com/category/portable-audio-video-players-voice-recorders-electronic-books/>)

Power supplies
(<https://4youdaily.com/category/power-supplies/>)

Power supplies, adapters, power supplies
(<https://4youdaily.com/category/power-supplies-adapters-power-supplies/>)

Printers, MFPs, Faxes
(<https://4youdaily.com/category/printers-mfps-faxes/>)

Printers, print servers, scanners, copiers, MFPs
(<https://4youdaily.com/category/printers-print-servers-scanners-copiers-mfps/>)

Processors
(<https://4youdaily.com/category/processors/>)

Programs, Utilities
(<https://4youdaily.com/category/programs-utilities/>)

RAM modules, memory cards, flash drives, card readers (<https://4youdaily.com/category/ram-modules-memory-cards-flash-drives-card-readers/>)

Rapid tests (<https://4youdaily.com/category/rapid-tests/>)

Really (<https://4youdaily.com/category/really/>)

Reports (<https://4youdaily.com/category/reports/>)

Rumors (<https://4youdaily.com/category/rumors/>)

Russian science and industry
(<https://4youdaily.com/category/russian-science-and-industry/>)

Samsung
(<https://4youdaily.com/category/samsung/>)

Sem categoria (<https://4youdaily.com/category/sem-categoria/>)

Sensors and sensor systems
(<https://4youdaily.com/category/sensors-and-sensor-systems/>)

Servers, clusters, supercomputers, industrial and multiprocessor computers
(<https://4youdaily.com/category/servers-clusters-supercomputers-industrial-and-multiprocessor-computers/>)

Smart watch (<https://4youdaily.com/category/smart-watch/>)

Smartphones
(<https://4youdaily.com/category/smartphones/>)

SoC and controller chips
(<https://4youdaily.com/category/soc-and-controller-chips/>)

Social networks
(<https://4youdaily.com/category/social-networks/>)

Software (<https://4youdaily.com/category/software/>)

Software News
(<https://4youdaily.com/category/software-news/>)

Sony (<https://4youdaily.com/category/sony/>)

Space (<https://4youdaily.com/category/space/>)

Speakers, headphones, audio systems
(<https://4youdaily.com/category/speakers-headphones-audio-systems/>)

Special Huawei 2018
(<https://4youdaily.com/category/special-huawei-2018/>)

Summary
(<https://4youdaily.com/category/summary/>)

System logic sets
(<https://4youdaily.com/category/system-logic-sets/>)

Tablet computers and smartbooks
(<https://4youdaily.com/category/tablet-computers-and-smartbooks/>)

Technology and IT market. news
(<https://4youdaily.com/category/technology-and-it-market-news/>)

Testing and configuring PC
(<https://4youdaily.com/category/testing-and-configuring-pc/>)

Text editors (<https://4youdaily.com/category/text-editors/>)

The Internet (<https://4youdaily.com/category/the-internet/>)

The world of robotics
(<https://4youdaily.com/category/the-world-of-robotics/>)

TV sets (<https://4youdaily.com/category/tv-sets/>)

Unix systems (<https://4youdaily.com/category/unix-systems/>)

Video cards (<https://4youdaily.com/category/video-cards/>)

Viruses, trojans, software vulnerabilities, security issues (<https://4youdaily.com/category/viruses-trojans-software-vulnerabilities-security-issues/>)

Vivo (<https://4youdaily.com/category/vivo/>)

Wearable electronics
(<https://4youdaily.com/category/wearable-electronics/>)

Wireless network
(<https://4youdaily.com/category/wireless-network/>)

Xiaomi (<https://4youdaily.com/category/xiaomi/>)

ΩΣ Ωινδωσ
(<https://4youdaily.com/category/%cf%89%cf%83-%cf%89%ce%b9%ce%bd%ce%b4%ce%bf%cf%89%cf%82/>)

META

Log in (<https://4youdaily.com/wp-login.php>)

Entries feed (<https://4youdaily.com/feed/>)

Comments feed
(<https://4youdaily.com/comments/feed/>)

WordPress.org (<https://wordpress.org/>)

YOU MAY HAVE MISSED

2 min read

Games
(<https://4youdaily.com/category/games/>)

Technology and IT market. news
(<https://4youdaily.com/category/technology-and-it-market-news/>)

Contributors 11-11: Memories Retold Introduce Road 96 – Procedural Generated Road Adventure
(<https://4youdaily.com/games/contributors-11-11-memories-retold-introduce-road-96-procedural-generated-road-adventure/>)

5 days ago admin
(<https://4youdaily.com/author/admin/>)

2 min read

Space
(<https://4youdaily.com/category/space/>)

Technology and IT market. news
(<https://4youdaily.com/category/technology-and-it-market-news/>)

Chinese spacecraft “Chang’e-5” with lunar samples completed the first of two maneuvers to escape the Moon
(<https://4youdaily.com/space/chinese-spacecraft-chang-e-5-with-lunar-samples-completed-the-first-of-two-maneuvers-to-escape-the-moon/>)

5 days ago admin
(<https://4youdaily.com/author/admin/>)

2 min read

Games
(<https://4youdaily.com/category/games/>)

Technology and IT market. news
(<https://4youdaily.com/category/technology-and-it-market-news/>)

New trailer for co-op shooter Outriders gives tips on survival on Enoch
(<https://4youdaily.com/games/new-trailer-for-co-op-shooter-survival-on-enoch/>)

5 days ago admin
(<https://4youdaily.com/author/admin/>)

2 min read

Cars, motorcycles, vehicles
(<https://4youdaily.com/category/cars-motorcycles-vehicles/>)

Technology and IT market. news
(<https://4youdaily.com/category/technology-and-it-market-news/>)

Tesla's China Manufacturing Will Drive Electric Vehicle Sales in China by 40% in 2021
(<https://4youdaily.com/cars-motorcycles-vehicles/teslas-china-manufacturing-will-drive-electric-vehicle-sales-in-china-by-40-in-2021/>)

5 days ago admin
(<https://4youdaily.com/author/admin/>)

Exhibit G



Memory Technology and Overall Trends in the Semiconductor Industry

Dr. Handel H. Jones

Founder and CEO, International Business Strategies, Inc.

A close-up, low-angle shot of a semiconductor wafer with numerous gold-colored pins protruding from its surface. The image is overlaid with a purple and blue gradient.

CONNECT

International Business Strategies Background

- Has been in business for over 28 years
- Previous experience in managing 1.5K+ engineers at Rockwell International, which included avionics, communications, and semiconductors. Strong emphasis on communications
- Interface with most global leaders in electronics industry, with customers in U.S., Europe, South Korea, Japan, Taiwan, China, India, etc
- Interface and support for major global corporations such as Intel, Qualcomm, Broadcom, Microsoft, Nokia, Samsung, SK Hynix, Sony, Toshiba, Apple, Cisco, Huawei, IBM, Fujitsu, Canon, NEC, Hitachi, Renesas, TSMC, STMicroelectronics, TI, ARM, Cadence, Synopsys, Mentor Graphics, Seagate, Globalfoundries, SMIC, NXP, and others
- Participated with French Government on their advanced technology initiatives
- Interface and support for financial institutions such as Goldman Sachs, Carlyle, Blackstone, CitiGroup, Warburg Pincus, Walden, KKR, Morgan Stanley, Credit Suisse, BNP Paribas, Bain Capital, Bank of America, TPG, and others
- Involved with advanced technology concepts, price-sensitive platforms for smartphone and other high-volume platforms, and high-performance infrastructure companies on global basis
- Strong expertise in China. Published two books on [China: China's Globalization \(How China Becomes No. 1\)](#) and [Chinamerica](#) (McGraw Hill). Forbes blog contributor, China Daily articles, Global Times editorials, EE Times, etc
- Involved in number of due diligence projects on number of IPOs
- Support for strategic initiatives for number of global technology leaders

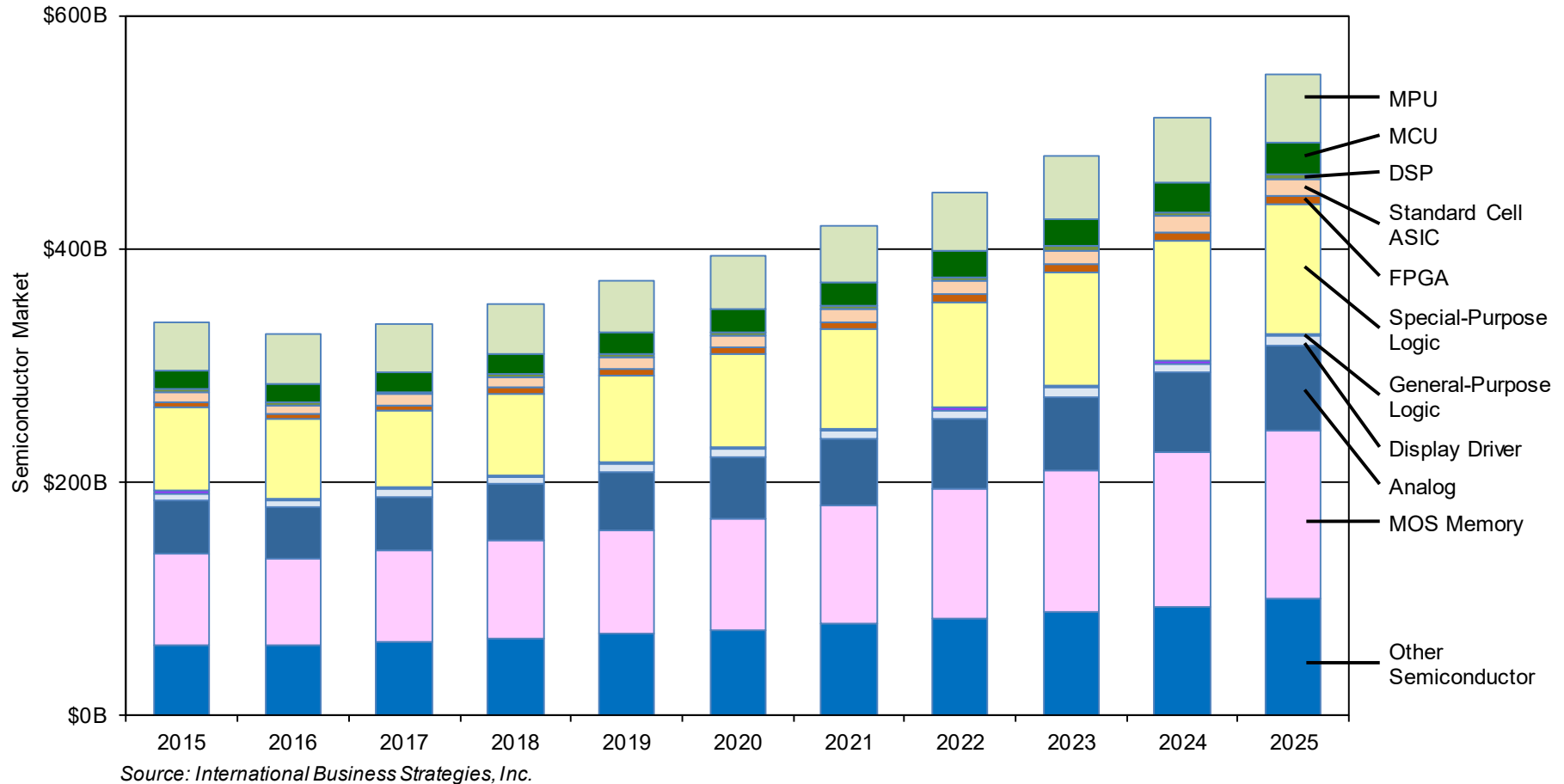
IBS has high market share on technology and strategy business

Key Issues in Memory Technology

- Memories are becoming key part of system architectures
- Heterogeneous processing is driving concept of shared memory, with need for higher throughput and lower power consumption
- 3D XPoint can change memory architectures
 - ZNAND from Samsung is potential competitor
 - Vertical STT structures are being developed, but manufacturing is very difficult
- DRAM gigabyte prices have declined 50% in past 12 months, and key reason is predatory strategies of leader
- NAND gigabyte prices have declined 40% in past 12 months, with strong market share pressures
 - Samsung's 3D NAND has cost crossover with 2D NAND in 48 layers
 - Shortages are emerging for NAND, and gigabyte prices are increasing
- eNVM structures are being enhanced, but with 28nm being most advanced technology node
- New eNVM technology is also being developed

CAPEX for 3D NAND memory is strong in 2016, but DRAM is flat

Semiconductor Market by Product



Semiconductor market is declining in 2016

Memory Market by Product

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
DRAM (\$M)	45,682	39,803	42,641	46,060	49,335	52,419	55,585	59,315	63,419	67,954	72,901
Growth rate (%)	NA	(12.87)	7.13	8.02	7.11	6.25	6.04	6.71	6.92	7.15	7.28
Percent total (%)	58.42	54.35	53.75	54.60	55.66	55.35	54.28	53.03	52.23	51.19	50.20
NAND Flash (\$M)	28,978	30,039	33,419	35,112	36,154	39,065	43,468	49,034	54,278	60,828	68,026
Growth rate (%)	NA	3.66	11.25	5.07	2.97	8.05	11.27	12.80	10.69	12.07	11.83
Percent total (%)	37.06	41.01	42.12	41.62	40.79	41.25	42.45	43.83	44.71	45.82	46.85
Other memory (\$M)	3,538	3,399	3,276	3,186	3,143	3,227	3,350	3,512	3,714	3,971	4,288
Growth rate (%)	NA	(3.94)	(3.61)	(2.75)	(1.34)	2.68	3.79	4.84	5.76	6.92	7.97
Percent total (%)	4.52	4.64	4.13	3.78	3.55	3.41	3.27	3.14	3.06	2.99	2.95
TOTAL Memory (\$M)	78,198	73,241	79,336	84,358	88,632	94,711	102,403	111,861	121,411	132,753	145,215
Growth rate (%)	NA	(6.34)	8.32	6.33	5.07	6.86	8.12	9.24	8.54	9.34	9.39

Source: International Business Strategies, Inc.

CAGR of memory is higher than total semiconductor market

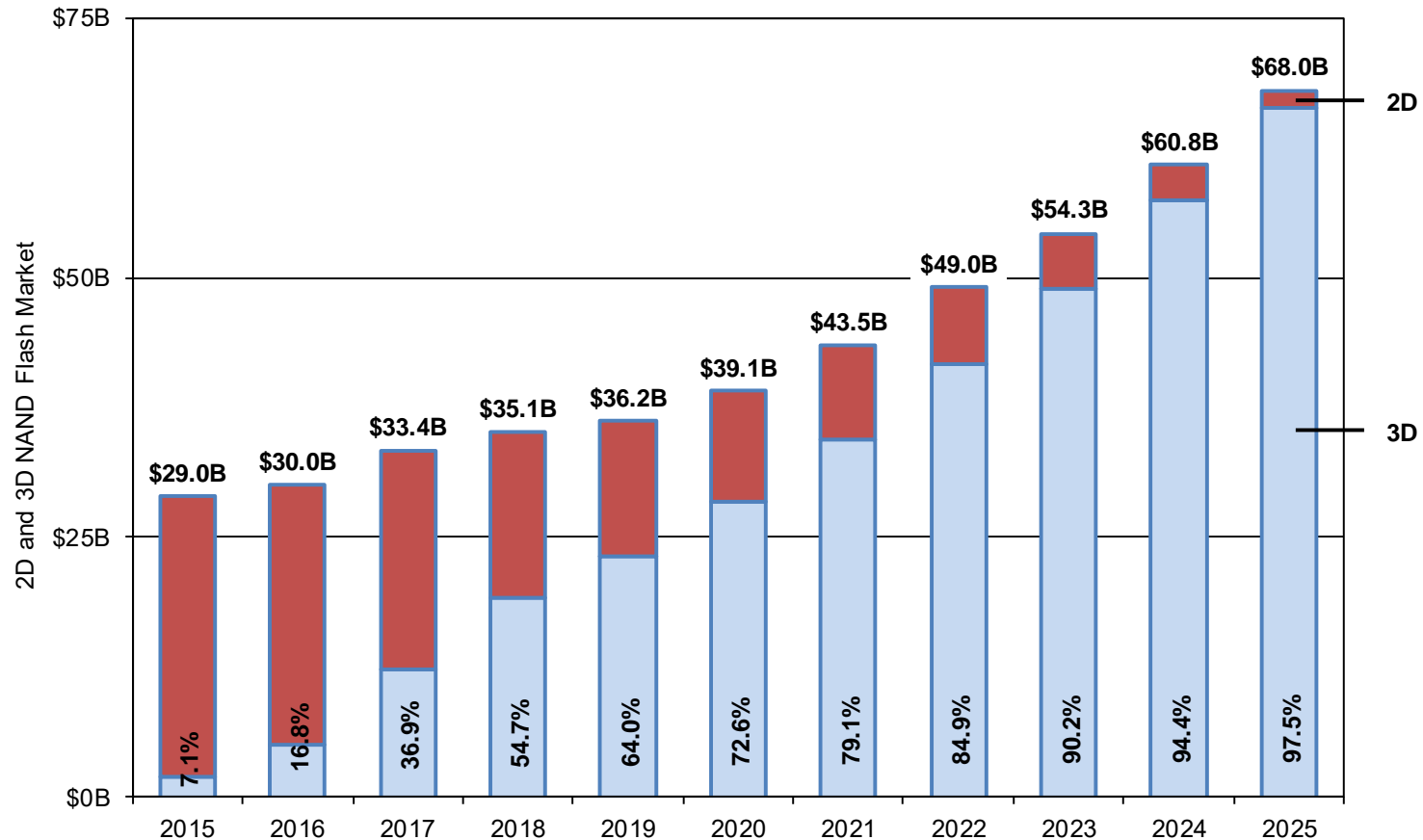
NAND Flash Cost Summary

Cost per GB (\$)	MLC	TLC
2D		
With depreciation	0.318	0.230
Without depreciation	0.197	0.137
3D		
32 layers with depreciation	0.281	0.190
32 layers without depreciation	0.219	0.148
48 layers with depreciation	0.173	0.116
48 layers without depreciation	0.137	0.091
64 layers with depreciation	0.157	0.105
64 layers without depreciation	0.131	0.076

Source: International Business Strategies, Inc.

Cost crossover between 3D NAND and 2D NAND

NAND Flash Market



Source: International Business Strategies, Inc.

Revenues of 3D NAND will be higher than 2D NAND in 2018

Key Issues in NAND Flash

- 3D NAND is positioned to dominate NAND Flash market
 - 10X or higher endurance than 2D NAND
 - Lower latency
 - Higher system performance support
- 64 layers could be in volume production in 2017
 - After 64 layers, cost saving will decline on relative basis
- Samsung is 12 to 18 months ahead of competitors in 3D NAND
 - Samsung has 512GB SSD in BGA format with PCIe interface
 - ZNAND is SLC but fill part of performance gap between DRAM and NAND Flash
- \$24B is being invested to build facility in Wuhan (China), with Tsinghua Unigroup as lead investor
- Intel is manufacturing 3D NAND in Dalian (China) along with 3D XPoint, which can change architecture of system memory

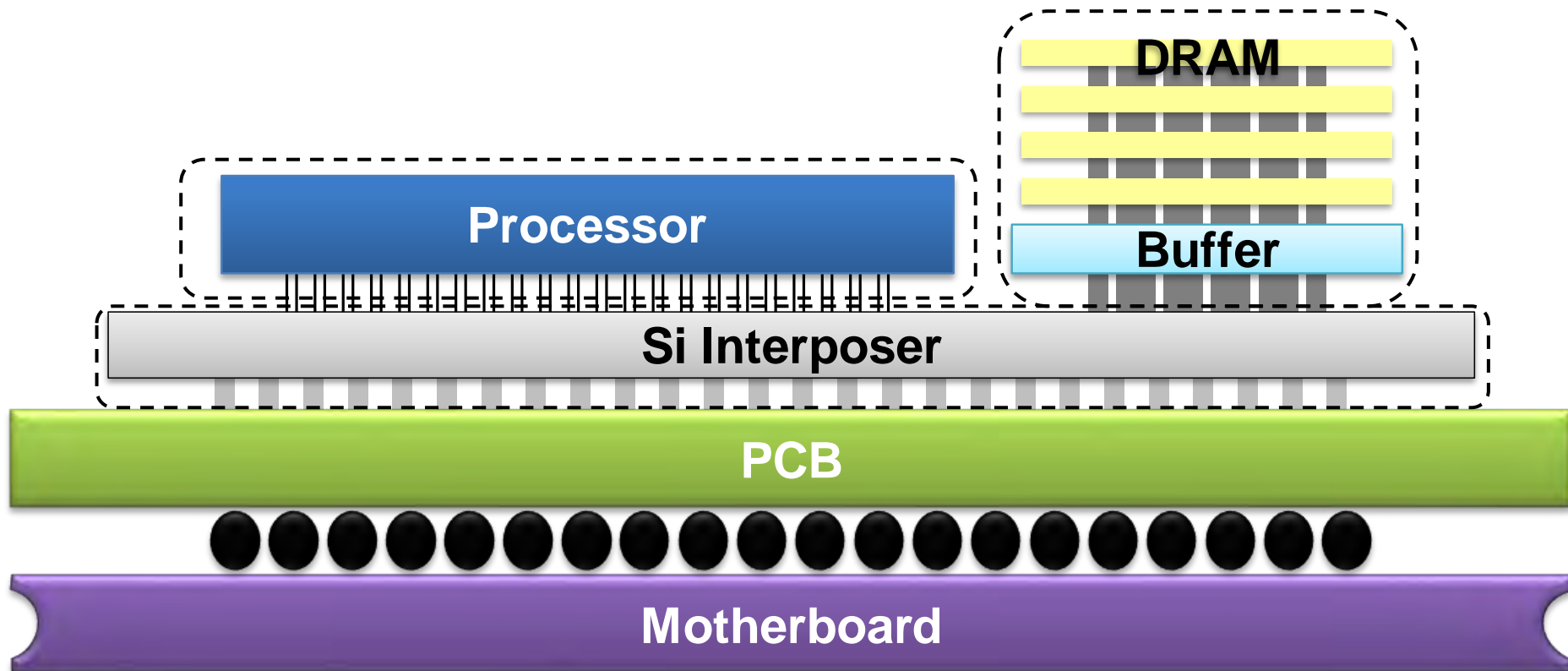
3D NAND is disruptive new technology

Key Issues in DRAM

- Samsung is in initial production of 8Gb in 18nm
 - New design structure can shrink to 15nm
 - Samsung is developing vertical STT, but device structure is complex, with access time of 10ns and 7.5 μ A for writing one bit
- SK Hynix is at 20nm for DRAM
 - In relatively strong market position
 - Has been follower of Samsung
- Micron Technology has wafer fabs in multiple locations
 - May need external funding to track CAPEX of Samsung
 - Expect Micron to participate in China's memory ecosystem
- Wide bandwidth architectures as supported by HBM2 will have high growth
- STT and RRAM structures are being developed but are not close to high-volume production, which means saturation of DRAM functionality
- Changes in system architecture can reduce amount of DRAM needed and give high throughput, but power consumption is still problem

DRAM is at plateau of innovation

Samsung's 4GB HBM2



Source: Samsung Electronics Co. Ltd.

Initial target is high-performance data centers

Key Issues in eNVM

- New eNVM device structures at 28nm are being developed by several companies that are interfacing with TSMC and other foundry vendors
- Companies are developing RRAM and MRAM, with indications that MRAM will be key technology in intermediate time frame
- Many IoT applications need eNVM along with ultra-low power technology
- Best eNVM process options for IoT applications include following:
 - TSMC's ultra-low power technology, where 28nm will have long lifetime
 - 22nm FD SOI will be widely used in future
- Key problem with eNVM is high cost
 - Need to keep number of masks to 10% of total masks, eg, four to five masks for 28nm bulk CMOS
 - For MRAM, need embedded transistor as well as BEOL processing
- Chip-scale packaging is option but has cost and size penalties

High-cost of eNVM is significant challenge for semiconductor industry

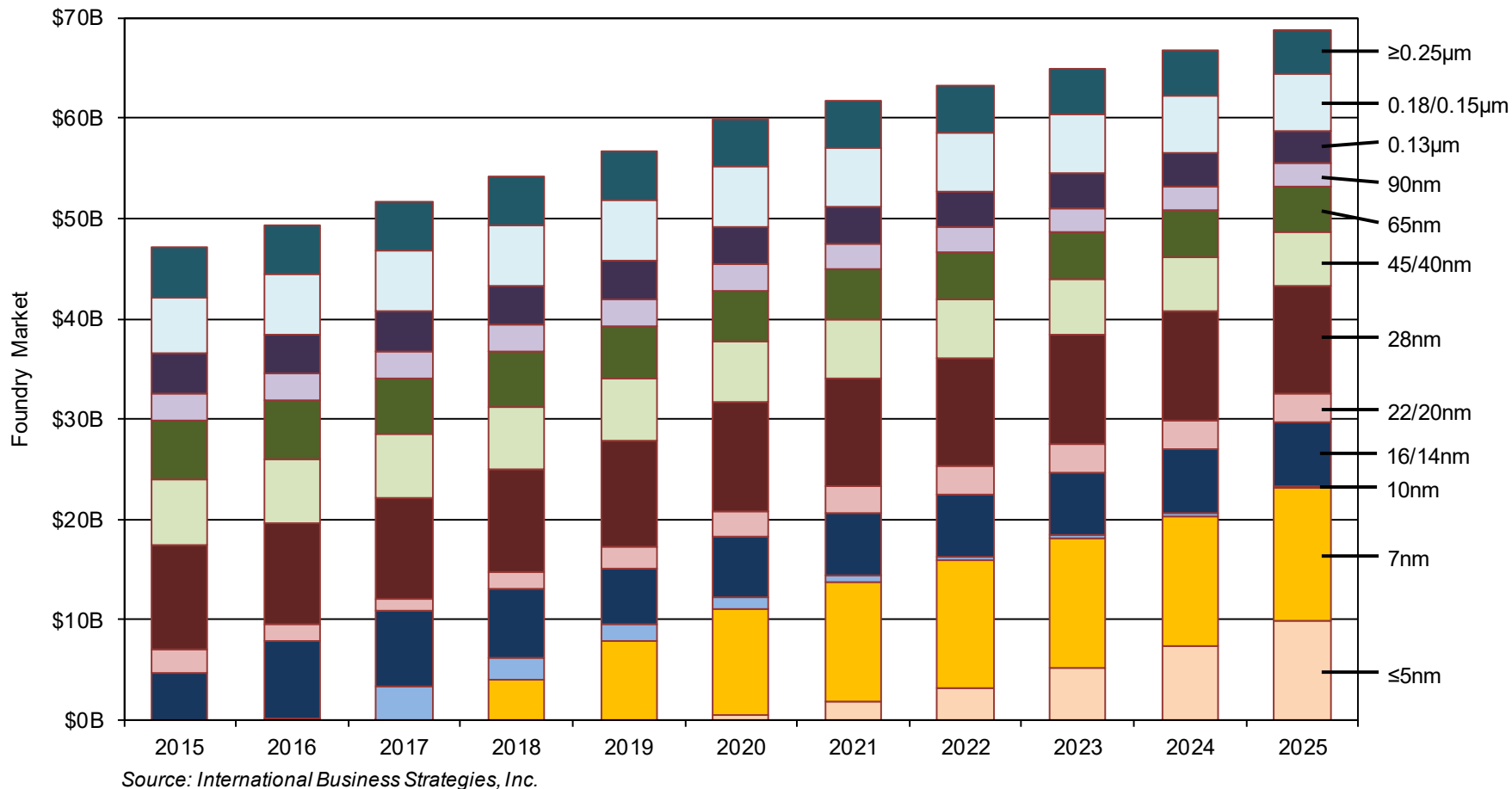
Wafer Fab Activities in China

	Expenditures (\$B)		Location	Product	Technology
	Total	2016			
Yangtze River Storage Technology	24.0	0.5	Wuhan	3D NAND	30nm
SMIC	15.0	2.5	Beijing, Shanghai	Logic	40nm, 28nm
UMC and partners	6.2	0.1	Xiamen	Logic	55nm, 40nm, 28nm
	5.3	0.1	Fujian	DRAM	32nm
Samsung	7.5	0.4	Xi'an	3D NAND	30nm
Intel	5.5	0.5	Dalian	3D NAND	30nm
SK Hynix	5.5	0.1	Wuxi	DRAM	20nm
TSMC	3.0	0.5	Nanjing	Logic	16nm
Globalfoundries and partners	2.0 to 3.0	0.01	Chongqing	Logic	130/180nm to 40nm
Powerchip and partners	2.0 to 3.0	1.0	Hefei	LCD driver IC	90nm, 110nm, 150nm

Source: International Business Strategies, Inc.

Strong emphasis on memory

Foundry Market by Technology Node



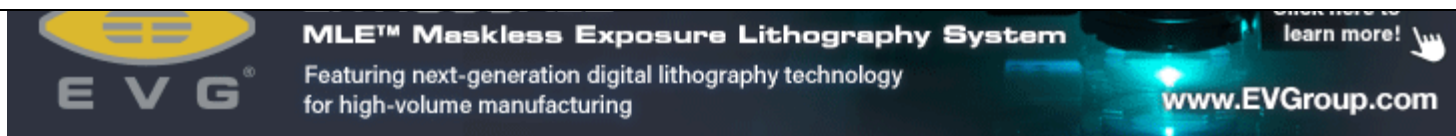
Growth of foundry market is higher than semiconductor market

Conclusion

- 3D NAND growth is high, with mobile platforms as largest consumption segment
 - 2D capacity is migrating to 3D capacity
 - Shortages are emerging in NAND market, and prices will increase
- Need breakthrough in DRAM technology
 - Expect large investments in China
 - However, Chinese DRAM vendors will not have major impact on supply chain before 2020
- Specialty memory has good growth potential, but it is difficult to change from being niche vendor to mainstream vendor
- Intel is trying to change architecture of memory for data centers, with 3D XPoint and 3D NAND as key building blocks
 - Competitive offering will be ZNAND with HBM2 and 1024-bit wide access in future
 - Heterogeneous processing requires adoption of shared memory architectures
- Limits of eNVM technology are slowing migration to smaller feature dimensions
 - 28nm roadmap is being developed, but with price premiums
 - Growth of foundry market segments, eg, automotive and IoT, depends on enhancing eNVM structures

Need to accelerate technology enhancements for memory

Exhibit H



Home □ 2019 □ September □ 13 □

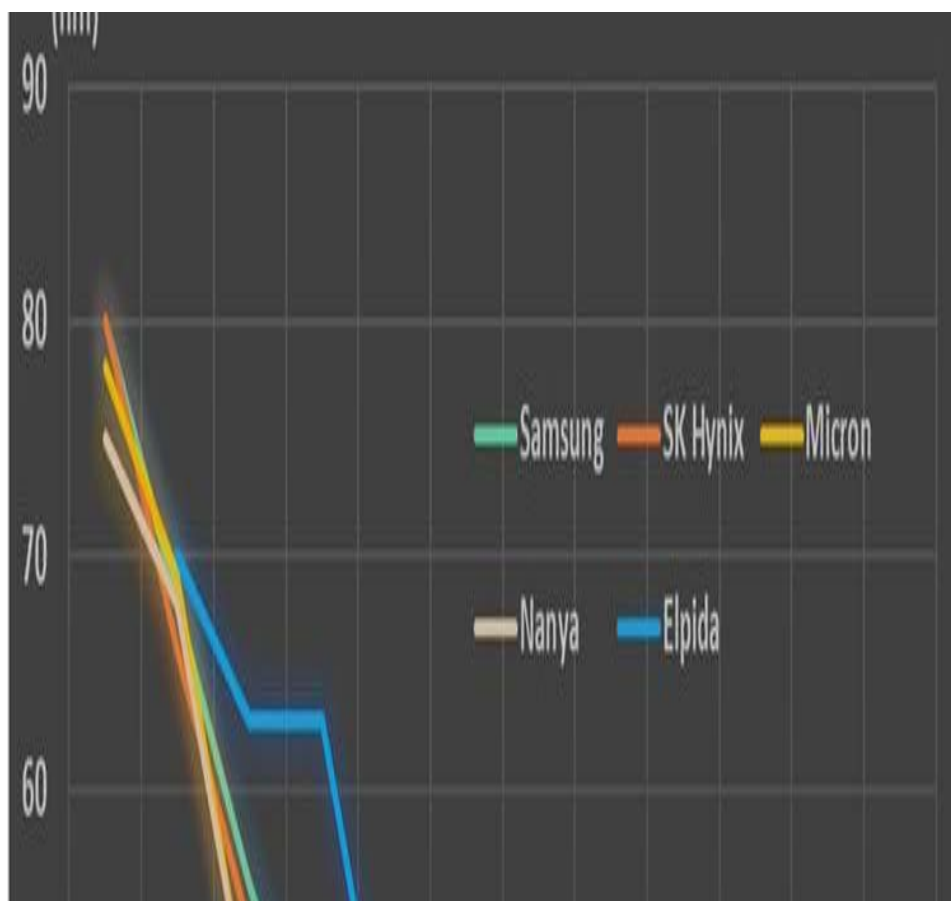
DRAM, NAND and Emerging Memory Technology Trends and Developments in 2019

DESIGN

DRAM, NAND and Emerging Memory Technology Trends and Developments in 2019

PETE SINGER - SEPTEMBER 13, 2019

0 8.5K VIEWS





Jeongdong Choe, PhD., TechInsights, Ottawa,
Canada

DRAM cell scaling down to a 17nm design rule has already been productized by major DRAM players including Samsung, Micron and SK Hynix (Figure 1). Currently, they are developing n+1 (16nm) and n+2 (15nm or beyond) so-called

1z, 1a and 1b generation devices, which means the DRAM cell design rule might be able to further scale down to sub-15 nm without adopting Extreme Ultraviolet (EUV) lithography for DRAM cell patterning.

The cell design scaling down process is slowing due to many scaling issues including patterning, leakage and sensing margin. And so far, EUV adoption on DRAM process is not cost effective. It appears that the 14nm DRAM cell design rule would be the last node if DRAM cell architecture keeps the current 1T1C with B-RCAT and cylindrical capacitor.

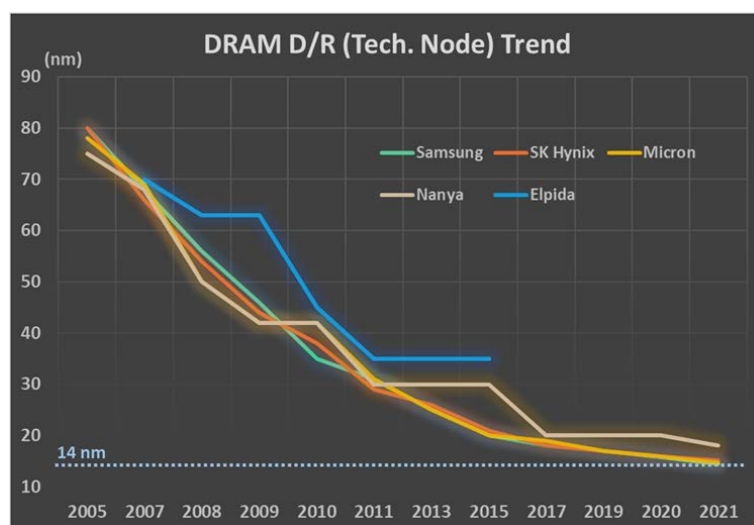


Figure 1. DRAM design rule trend for major players: Samsung, SK Hynix, Micron and Nanya. Year 2020 and 2021 on expectation.

An examination of teardowns and analyses of recently released smartphones found that the phones use 1x nm and 1y nm design rule LPDDR4X DRAM devices (Figure 2). For example, Samsung's Galaxy S10 products like the S10, S10+ and S10 5G have 1y nm LPDDR4X devices with an 8 Gb DRAM die floor plan in the 8 GB or 12 GB package. These devices contain 8 or 12 dies in the package.

	5	5C, 5S	6, 6+	6S, 6S+	SE, 7, 7+	8, 8+, X	XR, XS/XS Max	
Apple iPhone	• LPDDR2	• LPDDR2, 3	• LPDDR3, 4	• LPDDR4	• LPDDR4	• LPDDR4	• LPDDR4X	
	• 512 MB/die	• 512 MB/die	• 512 MB/die	• 512 MB/die	• 512 MB/die • 768 MB/die • 1 GB/die	• 512 MB/die • 768 MB/die	• 1 GB/die 3 GB (XR) 4 GB (XS/XS Max)	
	• Elpida • SK Hynix	• SK Hynix • Micron	• Samsung • SK Hynix • Micron	• Samsung	• Samsung • SK Hynix	• SK Hynix • Micron	• Micron	
Samsung Galaxy	S3, Note 2	S4, Note 3	S5, Note 4	S6, Note 5	S7, S7 E, Note 7	S8, S8+, Note 8	S9, S9+	S10E, S10, S10+
	• LPDDR2	• LPDDR2, 3	• LPDDR3	• LPDDR4	• LPDDR4	• LPDDR4X	• LPDDR4X	• LPDDR4X
	• 512 MB/die	• 512 MB/die	• 512 MB/die • 768 MB/die	• 384 MB/die • 512 MB/die	• 512 MB/die • 1 GB/die	• 1 GB/die	• 1 GB/die 8 GB/PKG 12 GB/PKG(S9) 6 GB/PKG(S9+)	• 1 GB/die 8 GB/PKG 12 GB/PKG(S10+) 12 die/PKG
	• Samsung	• Samsung	• Samsung	• Samsung	• SK Hynix Samsung	• Samsung	• Samsung	• Samsung
	2012	2013	2014	2015	2016	2017	2018	2019

Figure 2. Low power mobile DRAM components used on smartphones; Apple iPhone and Samsung Galaxy.

Bit density on DRAM die reached 0.237 Gb/mm² on Samsung's 1y nm LPDDR4X 8 Gb die, which is a 25.4% increase from the 1x LPDDR4X die (Figure 3). Micron recently introduced its 1y nm 8 Gb DDR4 DRAM die with 0.205 Gb/mm², a 22.7% increase from its 1x DDR4 die. Additionally, SK Hynix 1x LPDDR4 technology uses a 0.191 Gb/mm² bit density.

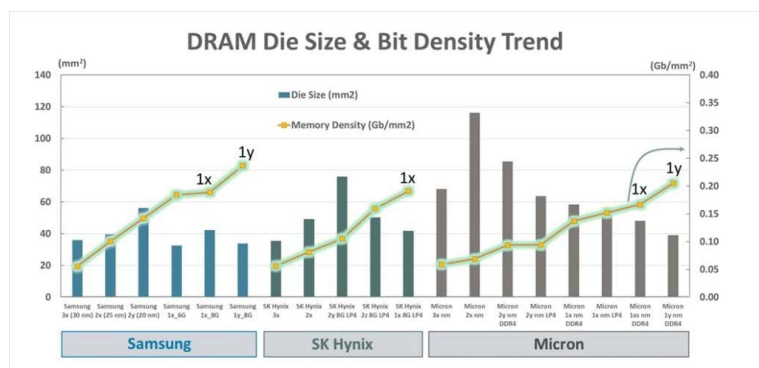


Figure 3. DRAM die size and memory bit density trend from Samsung, SK Hynix and Micron, including 1x and 1y generation .

Figure 4 shows a comparison of DRAM cell size from three major players, including the Samsung 1y nm and Micron 1y nm technology nodes. It is clear that Micron's 1x nm cell size was the same as Samsung's 2y nm, while Micron's 1y nm cell size (0.0024 μm²) is very close to Samsung's 1y nm (0.0023 μm²).

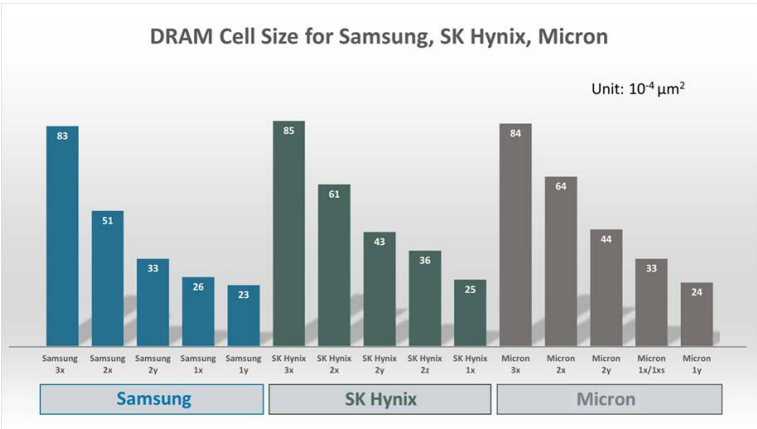


Figure 4. A comparison of DRAM cell size from Samsung, SK Hynix and Micron, including Samsung 1y and Micron 1y design rule.

Micron changed its cell design from the 1x nm technology node and kept it on 1y. They also revealed a 1xs version, which is a die shrink version of 1x nm on a DDR4 8Gb die. Micron uses the same design rule on DRAM cell array, while optimizing the memory peripheral design, especially on the write driver and column decoder/amplifier circuitry. Figure 5 shows a comparison of the Micron 1x and 1xs DDR4 DRAM dies from a peripheral functional block area ratio view.

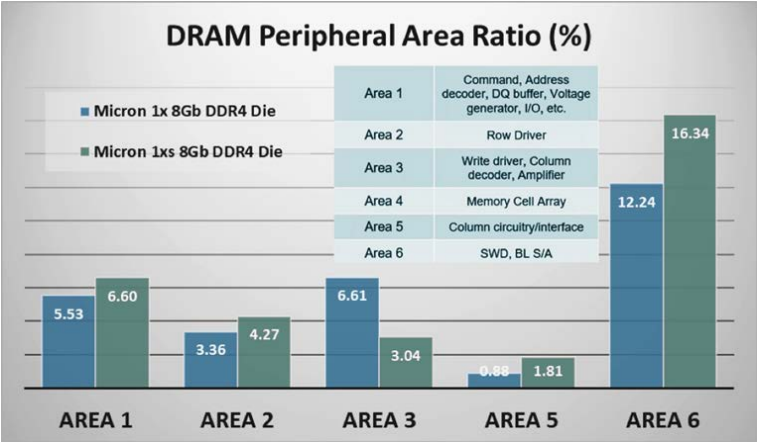


Figure 5. A comparison of DRAM peripheral functional block area ratio on 8 Gb DDR4 dies, 1x and 1xs.

SK Hynix' cell capacitor design and process have changed from cylindrical capacitor to pillar. Although their 1x nm DRAM cell capacitor structure has the same process as their previous

cylindrical capacitor, they insert a-Si into the inner capacitor, which means they only use the outer surface.

When it comes to graphic DRAM (GDRAM), both Samsung and Micron Technology revealed 8Gb GDDR6 packages with 8 Gb GDRAM dies for the NVIDIA GeForce RTX™ 2080. Samsung uses a 1x nm design rule with 0.303 Gb/mm² bit density, while Micron Technology uses 2y nm design rule with 0.093 Gb/mm² bit density. Samsung also introduced the world's first 16 Gb 1x nm GDRAM die for GDDR6 applications such as NVIDIA Quadro RTX™ 5000. Its bit density is 0.332 Gb/mm², which is the highest on a DRAM to date.

For high bandwidth memory applications, SK Hynix, Samsung, and Intel have commercially available HBM2 devices; only Micron has an HMC2 available. SK Hynix HBM2 products used on AMD Vega 10XT have a 2z nm tech node. The Samsung NVIDIA Tesla P100 PCIe and Intel SR3RM eighth generation Quad Core™ i5-8305G HBM2 products use Samsung's 2y nm HBM2 dies. Micron keeps the old DRAM cell design (3x nm) for HMC2 DRAM dies stacked together with an IBM 1234A controller die in the package.

NAND technology

All the major NAND die manufacturers have introduced 9XL 3D NAND devices. Samsung 92L V-NAND (V5), Toshiba and Western Digital Company (Western Digital) 96L BiCS4, Intel/Micron 96L FG CuA are already on the market, while the SK Hynix 96L PUC is expected to be released this year.

There have been many changes made when compared to the previous 3D NAND 64L and 72L

generation. Samsung's single vertical channel hole (VCH) etching technology is unique and may be used on their next generation (128L) as well. Samsung introduced both 256 Gb die and 512 Gb die with their 92L V-NAND technology. Toshiba/Western Digital changed NAND string architecture from single stack (64L) to double stack (48L+48L), which is different from Samsung's 92L. They also adopted a two-step metal contact etching process. Until 2016, all smartphones used 2D NAND; since 2017, both 2D and 3D NAND devices have been used on smartphones. Today's Samsung Galaxy and Apple iPhone, for example, utilize only 3D NAND devices as shown in Figure 6.

	Apple iPhone							
	5	5C, 5S	6, 6+	6S, 6S+	SE, 7, 7+	8, 8+, X	XR, XS/XS Max	
Apple iPhone	• MLC • eMMC	• MLC • eMMC • E2NAND3.0	• MLC • eMMC • E2NAND3.0	• MLC, TLC • eMMC • E3NAND	• MLC, TLC • eMMC	• MLC, TLC • eMMC	• TLC • Flash Storage	
	• 8 GB/die	• 8 GB/die	• 8 GB/die	• 8, 16 GB/die 32 GB/die	• 8, 16 GB/die 32 GB/die	• 16 GB/die 32 GB/die	• 32 GB/die 64 GB/die	
	• Toshiba • SK Hynix	• Toshiba • SK Hynix	• Toshiba • SK Hynix	• Toshiba • SanDisk • SK Hynix	• Toshiba • Samsung • SK Hynix	• Toshiba/WD • Samsung	• Toshiba/WD • Samsung • SK Hynix	
	Samsung Galaxy							
	S3, Note 2	S4, Note 3	S5, Note 4	S6, Note 5	S7, S7 E, Note 7	S8, S8+, Note 8	S, S9+	S10E, S10, S10+
Samsung Galaxy	• MLC • eMMC	• MLC • eMMC	• MLC • eMMC	• MLC • UFS	• MLC • UFS 2.0	• MLC • eMMC • UFS 2.1	• TLC • UFS 2.1	• TLC • UFS 2.1
	• 4, 8 GB/die	• 8 GB/die	• 8 GB/die	• 8 GB/die	• 8 GB/die	• 16 GB/die	• 256GB/die 64 GB (S9) 256 GB (S9+)	• 64L/92L 64L 256GB/die 64L 512GB/die 92L 512GB/die
	• Toshiba • Samsung • SanDisk	• Toshiba • Samsung	• Toshiba • Samsung	• Toshiba • Samsung	• Toshiba • Samsung	• Toshiba • Samsung	• Toshiba • Samsung	• Samsung
	2012	2013	2014	2015	2016	2017	2018	2019

Figure 6. NAND components used on smartphones; Apple iPhone and Samsung Galaxy.

The word line pad (WLP) connection area, the so-called staircase region, can be increased due to the number of total gates increased. All 3D NAND manufacturers newly optimized and designed the trim masks and process integration to reduce the area and cost/throughput. For example, Figure 7 shows a comparison of WLP connection area from Samsung and Toshiba/Western Digital on 48L, 64L and 92L/96L. The WLP connection area is just 0.82% of the full 64L die, and increased only by 13%, from 64L to 96L for Toshiba/Western Digital. Samsung has more effectively designed the trim (or slim) masks so that the penalty

regions smaller than Toshiba/Western Digital's, generation after generation.

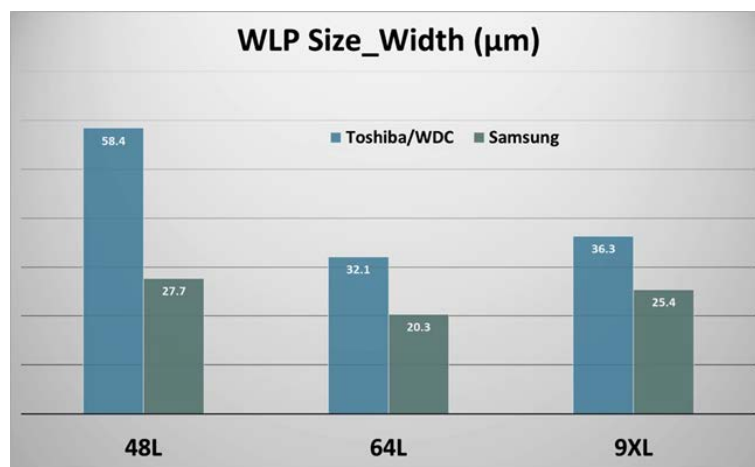


Figure 7. A comparison of WLP (word line pad) connection area from Samsung and Toshiba/Western Digital, including 48L, 64L and 92L/96L.

Samsung, Toshiba and Western Digital still use a selective epitaxial grown Si (SEG) process for the ground selector, which means they use the same source erase method as 64L products. Intel and Micron again stacked two NAND strings such as 48L plus 48L on CMOS circuitry called CMOS under Array (CuA). They keep the FG instead of using a CTF layer for the storage. SK Hynix 96L V4 periphery under cell (PUC) structure, or 4D NAND, is quite different from their previous BiCS. They removed pipe control gates, and for 9XL 3D NAND cell integration, they use their own unique vertical channel capping structures.

As the total number of gates increases, the vertical channel hole (VCH) height increases as shown in Figure. 8. Toshiba/Western Digital 96L and Intel/Micron 96L VCH's is over 6 μm. Both use double stacked 96L (two-step VCH etching). For the interface between two stacks, Intel and Micron Technology use multi-layer dielectrics (64L) or SiN layer only (96L), while Toshiba and Western Digital use SiO layer only.

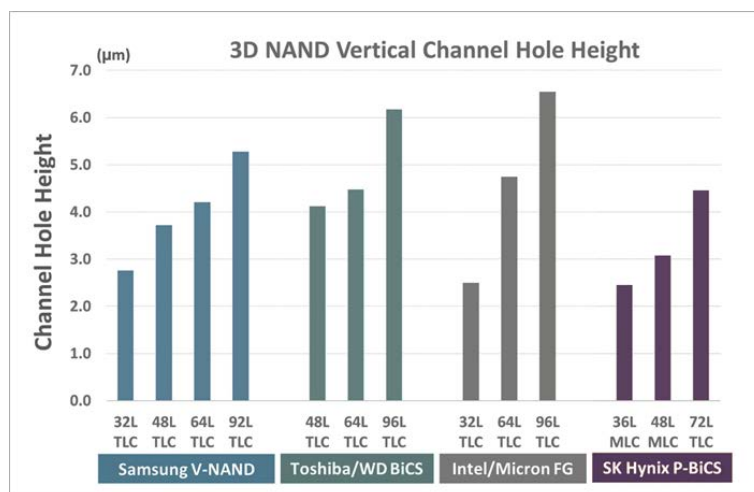


Figure 8. A comparison of vertical channel height from all the major 3D NAND players.

Today, 512 Gb 3D NAND dies are common. For example, Samsung offers both 512 Gb 64L TLC and 512 Gb 92L TLC dies. SK Hynix provides a 512 Gb 72L TLC die and Intel/Micron sells a 512 Gb 96L die.

3D NAND QLC devices are also available, especially from Samsung, Intel and Micron with 1 Tb 3D NAND die. Their bit densities are 5.6 Gb/mm² (for Samsung 64L QLC die) and 6.5 Gb/mm² (for Intel 64L QLC die), respectively. Intel/Micron keep a tile-type floor plan on their 64L QLC die and 96L TLC die.

Samsung also revealed its Z-NAND (Z-SSD) for the fast NAND application which may be competitive with Intel XPoint or Toshiba XL-FLASH. The first generation of Samsung's Z-NAND SSD products use 48L V-NAND cell array on 64 Gb SLC Z-NAND dies stacked together with one F-chip die in a package.

Embedded and emerging memory technology

As demand for embedded memories and MCU applications for AI and IoT increases, emerging memory technologies are also on the rise. In

addition, Intel has been applying their XPoint memory devices into NAND and storage products such as Optane SSD, Optane DC SSD, DC PM and even NVDIMM application. Emerging memories consist of MRAM, including STT-MRAM and SOT-MRAM, PCRAM including XPoint, ReRAM including CBRAM, OxRAM and Memristor, FeRAM and others including NRAM.

Everspin Technology already released its 256 Mb pMTJ STT-MRAM products. Everspin's first generation MRAM was a toggle-mode and AIO-based 180nm/90 nm product. Now, they market 64 Mb/256 Mb in-plane MTJ 90nm STT-MRAM and 256 Mb pMTJ 40 nm STT-MRAM products. Working together with Global Foundries, their 28nm/22nm FDX 1 Gb STT-MRAM is expected to be available soon. Figure 9 shows Everspin Technologies' MRAM products review.

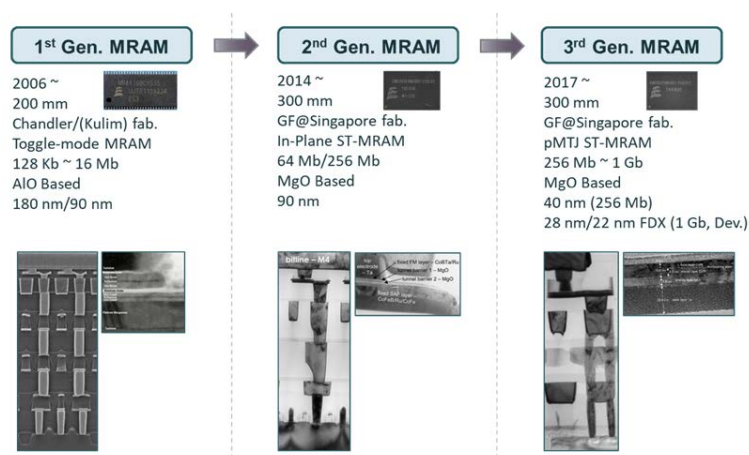


Figure 9. MRAM products revealed from Everspin Technologies.

Adesto Technology produced its second generation CBRAM, and is working on its third-generation solutions. The second generation used the same cell design rule as the first generation. However, the number of metals and CBRAM storage medium materials changed completely from Ag/GeS to Hf- and Te-based to a multi-layered structure. Many major DRAM,

NAND and logic makers are eager to jump into emerging memory markets. We anticipate seeing new memory products throughout 2019 and into 2020, including Samsung's 28 nm FDSOI STT-MRAM, TSMC eSTT-MRAM and eReRAM, Intel 22FFL STT-MRAM, Micron XPoint QunantX and Panasonic/UMC 28nm FDX ePCM. Table 1 briefly describes a comparison of ReRAM (CBRAM) first and second generation from Adesto Technologies.

Table 1. ReRAM (CBRAM) comparison between 1st and 2nd generation from Adesto Technologies.

ITEMS	RM24 Series	RM33 Series
Products	RM24EP128KS CBRAM	RM3313-XSNI-B-CBRAM
# Dies in PKG	1	1
Die Size	1.80 mm x 1.50 mm (2.70 mm ²)	1.02 mm x 1.24 mm (1.27 mm ²)
CBRAM Memory Capacity	128 Kb	32 Kb
Bit Density (/die, /Memory Block)	47.4 Kb/mm ² , 150.6 Kb/mm ²	25.2 Kb/mm ² , 67.7 Kb/mm ²
Portion of Memory Area on Die	0.85 mm ² , 31.5%	0.47 mm ² , 37.0%
Technology Node	130 nm	130 nm
# Metals	4 (3 Cu + 1 Al)	5 (4 Cu + 1 Al)
Contacted Gate Pitch/Length	488 nm / 107 nm	510 nm / 108 nm
Smallest WL/BL pitch	0.5 μm / 0.7 μm	0.5 μm / 0.7 μm
Cell Size	700 nm x 700 nm (0.49 μm ²)	685 nm x 733 nm (0.50 μm ²)
Top Electrode	M4 / Cu	M5 / W / Ta
CBRAM Storage Medium	TiN (66 nm) / Ag (92 nm) / GeS ₂ (47 nm)	TaTe (2 nm) / HfTeTaO (8 nm) / HfTeO (9 nm) / AlO (3nm)
Bottom Electrode	W / M3	Ta / W / M4
Gox Thickness	2.6 nm	2.4 nm
Foundry	Altis Semiconductor	Altis Semiconductor

Table 1. A comparison of ReRAM (CBRAM) first and second generation from Adesto Technologies.

Conclusion

TechInsights continually monitors innovations in DRAM, NAND and emerging technology products. Roadmaps detailing our findings and insights are available through TechInsights' website and are regularly updated. TechInsights' memory analysis is available through subscription products or individual reports. For more information, visit the TechInsights website.

About the author

Dr. Jeongdong Choe is a Senior Technical Fellow at TechInsights. He holds a Ph.D. in electronic

engineering and has over 27 years' experience in semiconductor process integration for DRAM, (V)NAND, SRAM and logic devices.

Dr. Choe's background includes positions as a Team Lead in R&D for SK-Hynix and Samsung, where he optimized process and device architectures with state-of-the-art technologies for mass production.

TAGS

EVERSPIN INTEL MICRON RERAM SAMSUNG TECHINSIGHTS



Pete Singer

Share This



Featured Products

SEMICONDUCTOR DIGEST
NEWS AND INDUSTRY TRENDS

GET SEMICONDUCTOR DIGEST MAGAZINE IN YOUR INBOX

SUBSCRIBE NOW

SEMICONDUCTOR DIGEST
NEWS AND INDUSTRY TRENDS

Get social with us!

CLICK HERE

PREVIOUS ARTICLE

DuPont Electronics & Imaging Divests

Compound Semiconductor
Solutions Business to SK
Siltron

NEXT ARTICLE

DVCon U.S. Serves Chip
Users Latest Tools and
Standards

[ABOUT US](#)

[TERMS & CONDITIONS](#)

[PRIVACY POLICY](#)

© 2020 Gold Flag Media LLC | All RIGHTS RESERVED

Exhibit I

1 Randall E. Kay (State Bar No. 149369)
rekay@jonesday.com
2 Douglas L. Clark (State Bar No. 279408)
dlclark@jonesday.com
3 JONES DAY
4 4655 Executive Drive, Suite 1500
San Diego, CA 92121.3134
Telephone: +1.858.314.1200
5 Facsimile: +1.844.345.3178

6 Patrick T. Michael (State Bar No. 169745)
pmichael@jonesday.com
7 Marcus S. Quintanilla (State Bar No. 205994)
mquintanilla@jonesday.com
8 JONES DAY
555 California Street, Suite 2600
9 San Francisco, CA 94104.1501
Telephone: +1.415.626.3939
10 Facsimile: +1.415.875.5700
Attorneys for Plaintiff
11 *MICRON TECHNOLOGY, INC.*

12
13 **UNITED STATES DISTRICT COURT**
14 **NORTHERN DISTRICT OF CALIFORNIA**

15 MICRON TECHNOLOGY, INC.,

16 Plaintiff,

17 v.

18 UNITED MICROELECTRONICS
19 CORPORATION, FUJIAN JINHUA
INTEGRATED CIRCUIT CO., LTD., and
20 DOES 1-10,

21 Defendants.

Case No. 3:17-CV-06932-MMC

**NOTICE OF SUBPOENA TO
PRODUCE DOCUMENTS**

TO ALL PARTIES AND THEIR ATTORNEYS OF RECORD:

PLEASE TAKE NOTICE that pursuant to Fed. R. Civ. P. 45, Plaintiff Micron Technology, Inc. ("Micron") will serve upon the following entity on June 4, 2019, or as soon as possible thereafter, the attached subpoena to produce documents:

KLA-Tencor Corporation
c/o C T Corporation System
818 W. Seventh St., Suite 930
Los Angeles, CA 90017

Dated: June 4, 2019

JONES DAY

By: s/ Douglas L. Clark
Douglas L. Clark

Attorneys for Plaintiff
MICRON TECHNOLOGY, INC.

I, Douglas L. Clark, declare:

I am a citizen of the United States and employed in San Diego County, California. I am over the age of eighteen years and not a party to the within-entitled action. My business address is 4655 Executive Dr., Suite 1500, San Diego, CA 92121. On June 4, 2019, I served a copy of the foregoing document(s):

• **NOTICE OF SUBPOENA TO PRODUCE DOCUMENTS TO KLA-TENCOR CORPORATION**



by transmitting *via e-mail or electronic transmission* the document(s) listed above to the person(s) at the e-mail address(es) set forth below.

***Attorneys for Defendants United
Microelectronics Corporation and Fujian
Jinhua Integrated Circuit Co., Ltd.***

Daniel Johnson, Jr., Esq.
Sean P. DeBruine, Esq.
Mario Moore, Esq.
Robert G. Litts, Esq.
DAN JOHNSON LAW GROUP, LLP
400 Oyster Point Boulevard, Suite 321
South San Francisco, CA 94080
Telephone No.: (415) 604-4500
Email: dan@danjohnsonlawgroup.com
sean@danjohnsonlawgroup.com
mario@danjohnsonlawgroup.com
robert@danjohnsonlawgroup.com

***Pro Hac Vice Attorney for Defendant
Fujian Jinhua Integrated Circuit Co., Ltd.***

Lyle B. Vander Schaaf, Esq.
Evi Thomae Christou, Esq.
Fei Hu, Esq.
Judy Kelly He, Esq.
Harold V. Johnson, Esq.
BRINKS GILSON & LIONE
1775 Pennsylvania Ave. NW, Ste. 900
Washington, DC 200006
Telephone: (202) 296-6941
Email: lvanderschaaf@brinksgilson.com
echristou@brinksgilson.com
fhu@brinksgilson.com
jhe@brinksgilson.com
hjohnson@brinksgilson.com

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on June 4, 2019, at San Diego, California.

s/ Douglas L. Clark
Douglas L. Clark

NAI-1507696019v1

AO 88B (Rev. 02/14) Subpoena to Produce Documents, Information, or Objects or to Permit Inspection of Premises in a Civil Action

UNITED STATES DISTRICT COURT

for the

Northern District of California

MICRON TECHNOLOGY, INC.

Plaintiff

v.

UNITED MICROELECTRONICS CORPORATION,
ET AL.*Defendant*

Civil Action No. 3:17-CV-06932-MMC

SUBPOENA TO PRODUCE DOCUMENTS, INFORMATION, OR OBJECTS
OR TO PERMIT INSPECTION OF PREMISES IN A CIVIL ACTION

To: KLA-Tencor Corporation c/o C T Corporation System, 818 W. Seventh St., Suite 930, Los Angeles, CA 90017

(Name of person to whom this subpoena is directed)

☒ **Production:** **YOU ARE COMMANDED** to produce at the time, date, and place set forth below the following documents, electronically stored information, or objects, and to permit inspection, copying, testing, or sampling of the material:

Documents and tangible things set forth in the attached Exhibit 1.

Place: JONES DAY, 555 California St., Suite 2600, San
Francisco, CA 94104.1501

Date and Time:

06/15/2019 10:00 am

☐ **Inspection of Premises:** **YOU ARE COMMANDED** to permit entry onto the designated premises, land, or other property possessed or controlled by you at the time, date, and location set forth below, so that the requesting party may inspect, measure, survey, photograph, test, or sample the property or any designated object or operation on it.

Place:

Date and Time:

The following provisions of Fed. R. Civ. P. 45 are attached – Rule 45(c), relating to the place of compliance; Rule 45(d), relating to your protection as a person subject to a subpoena; and Rule 45(e) and (g), relating to your duty to respond to this subpoena and the potential consequences of not doing so.

Date: 6/4/2019

CLERK OF COURT

OR

Signature of Clerk or Deputy Clerk


Attorney's signature

The name, address, e-mail address, and telephone number of the attorney representing (name of party) Micron Technology, Inc., who issues or requests this subpoena, are:

Douglas L. Clark, 4655 Executive Dr., Suite 1500, San Diego CA, 92121 dlclark@jonesday.com, 858.703.3133

Notice to the person who issues or requests this subpoena

If this subpoena commands the production of documents, electronically stored information, or tangible things or the inspection of premises before trial, a notice and a copy of the subpoena must be served on each party in this case before it is served on the person to whom it is directed. Fed. R. Civ. P. 45(a)(4).

Civil Action No. 3:17-CV-06932-MMC

PROOF OF SERVICE

(This section should not be filed with the court unless required by Fed. R. Civ. P. 45.)

I received this subpoena for *(name of individual and title, if any)* _____

on *(date)* _____.

☐ I served the subpoena by delivering a copy to the named person as follows: _____

_____ on *(date)* _____; or

☐ I returned the subpoena unexecuted because: _____

Unless the subpoena was issued on behalf of the United States, or one of its officers or agents, I have also tendered to the witness the fees for one day's attendance, and the mileage allowed by law, in the amount of \$ _____.

My fees are \$ _____ for travel and \$ _____ for services, for a total of \$ 0.00.

I declare under penalty of perjury that this information is true.

Date: _____

Server's signature

Printed name and title

Server's address

Additional information regarding attempted service, etc.:

Federal Rule of Civil Procedure 45 (c), (d), (e), and (g) (Effective 12/1/13)**(c) Place of Compliance.**

(1) For a Trial, Hearing, or Deposition. A subpoena may command a person to attend a trial, hearing, or deposition only as follows:

- (A) within 100 miles of where the person resides, is employed, or regularly transacts business in person; or
- (B) within the state where the person resides, is employed, or regularly transacts business in person, if the person
 - (i) is a party or a party's officer; or
 - (ii) is commanded to attend a trial and would not incur substantial expense.

(2) For Other Discovery. A subpoena may command:

- (A) production of documents, electronically stored information, or tangible things at a place within 100 miles of where the person resides, is employed, or regularly transacts business in person; and
- (B) inspection of premises at the premises to be inspected.

(d) Protecting a Person Subject to a Subpoena; Enforcement.

(1) Avoiding Undue Burden or Expense; Sanctions. A party or attorney responsible for issuing and serving a subpoena must take reasonable steps to avoid imposing undue burden or expense on a person subject to the subpoena. The court for the district where compliance is required must enforce this duty and impose an appropriate sanction—which may include lost earnings and reasonable attorney's fees—on a party or attorney who fails to comply.

(2) Command to Produce Materials or Permit Inspection.

(A) *Appearance Not Required.* A person commanded to produce documents, electronically stored information, or tangible things, or to permit the inspection of premises, need not appear in person at the place of production or inspection unless also commanded to appear for a deposition, hearing, or trial.

(B) *Objections.* A person commanded to produce documents or tangible things or to permit inspection may serve on the party or attorney designated in the subpoena a written objection to inspecting, copying, testing, or sampling any or all of the materials or to inspecting the premises—or to producing electronically stored information in the form or forms requested. The objection must be served before the earlier of the time specified for compliance or 14 days after the subpoena is served. If an objection is made, the following rules apply:

- (i) At any time, on notice to the commanded person, the serving party may move the court for the district where compliance is required for an order compelling production or inspection.
- (ii) These acts may be required only as directed in the order, and the order must protect a person who is neither a party nor a party's officer from significant expense resulting from compliance.

(3) Quashing or Modifying a Subpoena.

(A) *When Required.* On timely motion, the court for the district where compliance is required must quash or modify a subpoena that:

- (i) fails to allow a reasonable time to comply;
- (ii) requires a person to comply beyond the geographical limits specified in Rule 45(c);
- (iii) requires disclosure of privileged or other protected matter, if no exception or waiver applies; or
- (iv) subjects a person to undue burden.

(B) *When Permitted.* To protect a person subject to or affected by a subpoena, the court for the district where compliance is required may, on motion, quash or modify the subpoena if it requires:

- (i) disclosing a trade secret or other confidential research, development, or commercial information; or

(ii) disclosing an unretained expert's opinion or information that does not describe specific occurrences in dispute and results from the expert's study that was not requested by a party.

(C) *Specifying Conditions as an Alternative.* In the circumstances described in Rule 45(d)(3)(B), the court may, instead of quashing or modifying a subpoena, order appearance or production under specified conditions if the serving party:

- (i) shows a substantial need for the testimony or material that cannot be otherwise met without undue hardship; and
- (ii) ensures that the subpoenaed person will be reasonably compensated.

(e) Duties in Responding to a Subpoena.

(1) Producing Documents or Electronically Stored Information. These procedures apply to producing documents or electronically stored information:

(A) *Documents.* A person responding to a subpoena to produce documents must produce them as they are kept in the ordinary course of business or must organize and label them to correspond to the categories in the demand.

(B) *Form for Producing Electronically Stored Information Not Specified.* If a subpoena does not specify a form for producing electronically stored information, the person responding must produce it in a form or forms in which it is ordinarily maintained or in a reasonably usable form or forms.

(C) *Electronically Stored Information Produced in Only One Form.* The person responding need not produce the same electronically stored information in more than one form.

(D) *Inaccessible Electronically Stored Information.* The person responding need not provide discovery of electronically stored information from sources that the person identifies as not reasonably accessible because of undue burden or cost. On motion to compel discovery or for a protective order, the person responding must show that the information is not reasonably accessible because of undue burden or cost. If that showing is made, the court may nonetheless order discovery from such sources if the requesting party shows good cause, considering the limitations of Rule 26(b)(2)(C). The court may specify conditions for the discovery.

(2) Claiming Privilege or Protection.

(A) *Information Withheld.* A person withholding subpoenaed information under a claim that it is privileged or subject to protection as trial-preparation material must:

- (i) expressly make the claim; and
- (ii) describe the nature of the withheld documents, communications, or tangible things in a manner that, without revealing information itself privileged or protected, will enable the parties to assess the claim.

(B) *Information Produced.* If information produced in response to a subpoena is subject to a claim of privilege or of protection as trial-preparation material, the person making the claim may notify any party that received the information of the claim and the basis for it. After being notified, a party must promptly return, sequester, or destroy the specified information and any copies it has; must not use or disclose the information until the claim is resolved; must take reasonable steps to retrieve the information if the party disclosed it before being notified; and may promptly present the information under seal to the court for the district where compliance is required for a determination of the claim. The person who produced the information must preserve the information until the claim is resolved.

(g) Contempt.

The court for the district where compliance is required—and also, after a motion is transferred, the issuing court—may hold in contempt a person who, having been served, fails without adequate excuse to obey the subpoena or an order related to it.

EXHIBIT 1 TO KLA-TENCOR CORPORATION SUBPOENA

I. DEFINITIONS

1. “YOU,” “YOUR,” “YOURS,” and “KLA-TENCOR” as used herein, mean and refer to KLA-Tencor Corporation—the listed recipient of the attached subpoena—and all persons acting on its behalf.

2. The term “Plaintiff” and “Micron” means Micron Technology, Inc., and any of its affiliates including predecessors in interest, including but not limited to Micron Memory Taiwan (“MMT”), Elpida Memory, Inc. (“Elpida”), and Rexchip Electronics Corporation (“Rexchip”).

3. The term “UMC” mean United Microelectronics Corporation, and any past or present related company, division, subsidiary, parent, affiliate, joint venture, predecessor, successor, or assign, whether U.S. or foreign, whether incorporated or not, and all past or present directors, officers, employees, accountants, consultants, experts, investigators, advisors, representatives, agents and attorneys thereof, and any other person acting on their behalf.

4. The term “UMC Group (USA)” means UMC Group (USA), a UMC affiliate in the Northern District of California. In any request that references “UMC Group (USA),” that entity shall be understood as distinct from “UMC.”

5. The term “Jinhua” means defendant Fujian Jinhua Integrated Circuit Co., Ltd., and any past or present related company, division, subsidiary, parent, affiliate, joint venture, predecessor, successor, or assign, whether U.S. or foreign, whether incorporated or not, and all past or present directors, officers, employees, accountants, consultants, experts, investigators, advisors, representatives, agents and attorneys thereof, and any other person acting on their behalf.

6. The term “Defendants” means UMC and Jinhua.

7. The term “UMC/Jinhua DRAM Project” refers to an agreement entered into between UMC and Jinhua to develop DRAM technologies. As part of this agreement, Jinhua agreed to fund equipment for use by UMC. Any communications to YOU related to DRAM or requests to YOU for equipment to be used for DRAM processing and manufacturing on or after

January 2016 from either UMC or Jinhua should be assumed to be part of the UMC/Jinhua DRAM Project.

8. The term “person” or “persons” means a natural person, corporate or other business, governmental, organizational, or legal entity, unincorporated association, joint venture, sole proprietorship or any other organization, association or individual. The acts of a person are defined to include the acts of an individual, a director, officer, owner, member, employee, agent or attorney acting on the person’s behalf.

9. The terms “related,” “relating to,” “related to,” and “regarding” mean concerning, referring to, describing, summarizing, evidencing, constituting, containing, discussing, identifying or otherwise prepared in connection with the matter.

10. “Include” or “including” means including but not limited to, and should not be read to limit the scope of any discovery Request.

11. The terms “document,” “documents,” and “electronically stored information” have the broadest meanings possible under Rule 34(a) of the Federal Rules of Civil Procedure and include the meanings given the terms “writing” and “recordings” in Federal Rule of Evidence 1001. The terms include, but are not limited to: handwritings, memo pads, typewritings, paintings, photostats, photocopies, drawings, drafts, charts, graphs, other data or data compilations, photographs, electronic documents, images, electronic images, tape recordings, sound recordings, film and every other form of recording, stored in any medium from which information can be obtained either directly or indirectly from any tangible thing; any communications or representations including, but not limited to: letters, words, numbers, symbols, pictures, sounds or combinations thereof; and any stored information or databases, including, but not limited to: information stored in personal information software, risk management information systems, databases, flow charts, word processing software, desktop publishing software and spreadsheets, whether maintained on paper, floppy disks, zip disks, CD-ROMs, DVD-ROMs, flash drives, hard drives, tapes or other magnetic or electronic media or computer storage, or by any other manner. The terms include the originals, or if the originals are

unavailable, duplicates from which information can be obtained or translated. Any copies containing or having attached any alterations, notes, comments or other materials which are not included in the original, or other copies, shall be deemed separate documents or electronically stored information. All produced documents or electronically stored information shall include the original metadata associated with the documents or electronically stored information.

12. The term “identity,” “identify” or “identification” when used with reference to a natural person, means provide the following: his/her full name; his/her current and last known business affiliation, title, and employment position, including a description of duties and responsibilities; his/her current business address or, if that is not known, his/her last known business address; and his/her current residential address or, if that is not known, his/her last known residential address.

13. The term “Request(s)” shall mean one or more of the numerical Requests for Documents to be Produced under Section III, *infra*.

14. All undefined terms should be interpreted using common sense and the Federal Rules of Civil Procedure. This means that words should generally be understood to have their ordinary English language meaning as used in common vernacular. If certain terms have specific or specialized meaning in YOUR industry that make sense in the context of the request, then that specialized meaning should be applied.

15. If the Federal Rules of Civil Procedure provide a specific definition for a term, e.g., “Document,” then that definition is controlling.

16. The date(s) of these Requests should refer, unless otherwise indicated, from January 1, 2016 until present.

II. INSTRUCTIONS

1. Respond separately and completely to each Request.
2. YOU are requested to produce documents as the documents are kept in the usual and ordinary course of business.

3. YOU are requested to produce all documents responsive to these requests that can be located after a reasonably diligent search.

4. If YOU encounter any ambiguities when construing a Request or definition, respond with the matter deemed ambiguous and specify the construction used in responding.

5. If YOU withhold any document, electronically stored information, or thing based on an objection of, including but not limited to—privilege or the work-product doctrine (collectively, “privilege”), scope, burden, prematurity, confidentiality or expense—provide the following: the type of document, electronically stored information, or thing; the general subject matter of the document, electronically stored information, or thing; the creation date of the document, electronically stored information, or thing; and information sufficient to identify the document, electronically stored information, or thing, including, but not limited to the author, addressees, custodian, any other recipient of the document and the relationships of the author, addressee, custodian and any other recipient to each other. If YOU assert a privilege with regard to part of the material contained, disclose the non-privileged material to the fullest extent possible and indicate clearly the portions as to which the privilege is claimed.

6. If YOU withhold any document, electronically stored information, or thing on the grounds that production is unduly burdensome or expensive, describe the reasons that the production is unduly burdensome or expensive.

7. Produce all responsive documents, electronically stored information, or things along with all non-identical drafts and copies, without abbreviation or redaction.

8. In accordance with the Federal Rules of Civil Procedure, these requests are continuing. In the event that YOU (or YOUR attorneys) generate or become aware of any data or documents within the scope of these requests after YOUR responses and/or initial production of data and documents, such additional responsive information shall be timely furnished to Micron’s attorneys.

9. Please complete and sign the attached Certificate of Authenticity of Business Records and return it with the records requested by this subpoena.

III. REQUESTS FOR DOCUMENTS TO BE PRODUCED

1. All documents, including all communications with UMC, UMC Group (USA) or Jinhua, related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
2. Documents sufficient to show all amounts paid by UMC or Jinhua to YOU related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
3. Documents sufficient to show all equipment, tools, wafers, training or other products or services ordered by either UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
4. Documents sufficient to show all equipment, tools, wafers, training or other products or services supplied by YOU to either UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
5. Documents sufficient to show whether the ordered equipment, tools, wafers, training or other products or services in the two prior Requests were conveyed, shipped or otherwise provided to UMC and/or Jinhua.
6. Communications or documents sufficient to show all requirements, configurations or specifications provided to YOU for any tool, equipment or purchase related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
7. To the extent not previously provided, all documents related to any visits between YOU and either UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.
8. Documents sufficient to describe any demonstrations conducted by YOU for UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present. These documents should include at a minimum documents to show the purpose for the demonstration, what the demonstration consisted of, those involved in the demonstration, and YOUR achievement of any goals, including what those goals were and communications related to the same.

9. Documents, including all communications regarding any roadmaps or milestones related to the UMC/Jinhua DRAM Project from January 1, 2016 to present.

10. Any recipes provided to YOU by UMC or Jinhua related to the UMC/Jinhua DRAM Project from January 1, 2016 to present, as well as communications related to recipes.

11. Any documents containing non-public Micron information provided to YOU from either UMC or Jinhua.

12. All documents referring to Micron provided by either UMC or Jinhua to YOU.

13. All documents referring to Micron provided by YOU to either UMC or Jinhua.

NAI-1507696024v1

I, _____, CERTIFY AND DECLARE AS FOLLOWS:

1. I am over the age of 18 years and not a party to this action.

2. My business address is:

3. My employment, business, or occupation is:

4. I am the duly authorized Custodian of Records for **KLA-Tencor Corporation**, and I have the authority to certify such records.

5. On June ____, 2019, I was personally served with a Subpoena for Production of Business Records in the action entitled *Micron Technology, Inc. v. United Microelectronics Corporation, et al.*, Case No. 3:17-cv-06932-MMC (N.D. Cal.) ("Subpoena").

6. The documents accompanying this affidavit are true copies of the records described in the Subpoena that are in my possession, custody, or control as Custodian of Records.

7. The records were prepared in the ordinary course of business at or near the time of the acts, conditions, or events recorded.

I have delivered all of the records described in the Subpoena that are in my possession, custody or control along with this affidavit to Marcus S. Quintanilla (555 California St., Suite 2600, San Francisco, CA 94104).

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct.

DATED: _____, 2019

CUSTODIAN OF RECORDS